Transportation Further Study Measures In the *2001 Ozone Attainment Plan*

FSM 1 Particulate Traps for Urban Buses

FSM 2 Update HOV Lane Master Plan

FSM 3 Study Effects of High Speed Freeway Travel

FSM 4 Parking Management Incentive Program

FSM 5 Enhanced Housing Incentive/Station Access Program

and

Potential Episodic Control Measures

December 2002
Updated March 2003

Prepared by the

METROPOLITAN TRANSPORTATION COMMISSION

Transportation
Further Study Measures

in the

2001 Ozone Attainment Plan

FSM 1: Particulate Traps for Urban Buses
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I. Executive Summary

The 2001 Ozone Attainment Plan identified 11 “Further Study Measures” (FSM) that could have emission benefits, subject to a more detailed evaluation and review process (see Attachment A for brief descriptions). Under California Air Resource Board’s (CARB’s) approval of the Ozone Attainment Plan, the schedule for completion of Further Study Measures in the Ozone Plan was accelerated to December 2002. MTC is the lead on the evaluation of five (5) Further Study Measures for transportation, and the Air District is developing recommendations for the other measures.

The purpose of the analysis of these measures is to determine their potential emission benefits, costs, obstacles to implementation, and overall feasibility. If the evaluation indicates that one or more measures shows promise, they could be included as a control measure in the Ozone Plan. In addition, there is growing interest in a set of “episodic” controls that could be employed on the 6 to 7 Spare the Air days to provide significant reductions in motor vehicle emissions on the days most conducive to ozone formation. These measures would be more visable in terms of their effect on the traveling public and employers, but may be acceptable given the short period during which the measures would be in effect.

This report is a draft of the results for the FSMs that MTC explored, which are listed below:

- FSM 1: Study Benefits of Particulate Trap Retrofit Program for Urban Buses
- FSM 2: Update High Occupancy Vehicle (HOV) Lane Master Plan
- FSM 3: Study Effects of High Speed Travel (also an episodic measure)
- FSM 4: Implement Parking Management Incentive Program
- FSM 5: Enhanced Housing Incentive /Station Access Program

Preliminary transportation related episodic measures under review for Spare the Air days include:

- Reduced High Speed Travel on Freeways
- Limiting Use of 1981 and Older Cars
- Employee Telecommuting
- Free Transit

The general approach for all these measures was to define them in a way that would be amenable to analysis using reasonable assumptions about the scope of the measures and associated emission benefits. With several measures, MTC has collaborated with outside agencies and interest groups (e.g., car sharing agencies, CARB, and agencies that could contribute funding for an expanded Housing Incentive Program). However, the possible episodic measures will need to be reviewed in further detail with the implementing agencies.

Overall some of the programs do offer promise, while others now appear to have marginal benefits. Each of the measures can be summarized in brief below:

Further Study Measures

FSM 1: Particulate Traps for Urban Buses

This measure was not an ozone measure, but responded to public concerns about the impact of urban buses on communities near bus routes. MTC calculates that its funding priorities, which provided some $16+ million dollars to bus operators to repower buses with newer engines rather than replace existing buses, generated a net emission reduction of about 4 tons of particulate matter a year. There may be further opportunities to install state of the art particulate filters on a larger portion of the fleet as well.

FSM 2: Update HOV Lane Master Plan

This measure evaluates the emission benefits of various regional HOV lane configurations. The air quality analysis has used two different tools to assess the impact of HOV lanes on emissions: the regional travel demand forecast model and a highway operational model for the I-680 corridor over the Sunol Grade (this corridor is particularly well suited to HOV analysis since there no parallel routes for traffic diversion). The analysis focused on two areas: 1) an assessment of emissions for freeways with and without HOV lanes, and 2) a comparison of emissions among HOV alternatives that added HOV lanes, converted mixed flow lanes for HOV use, increased carpool occupancy requirements, and expanded express bus service on the HOV network. This effort also resulted in an updated HOV Master Plan, adopted by MTC in February 2003.

FSM 3: Study Effects of High Speed Freeway Travel

Some 34% of daily freeway vehicle miles of travel (VMT) occurs at speeds above 65 miles per hour, some as high as 85-90 miles per hour. MTC analyzed the effect of limiting travel speeds to the posted speed limit through expanded CHP enforcement. The analysis involved: 1) collecting the most recent Caltrans' freeway speed survey data, and 2) working with the CARB to develop vehicle emission factors for cars and trucks traveling over 65 mph. Emission reductions would be in the order of 1 to 3 tons per day regionwide, but would be lower if the measure concentrated enforcement on freeways in the central Bay Area and the morning time period. Given the low reductions projected and fact that the program would reduce Volatile Organic Compounds (VOC) and Nitrogen Oxides (NOx) by similar amounts (the Bay Area strategy focuses more on VOC control), the measure appears less promising than originally thought. Emission reductions from limiting big rigs trucks to 55 mph would have more significant results, but would primarily reduce NOx.

FSM 4: Parking Management Incentive Program

To conduct this analysis, MTC surveyed cities in the Bay Area to determine the amount of parking space that local governments provide that is free versus the amount that is charged. The thrust of the measure was to determine whether cities could help stimulated greater interest in pricing transportation facilities by enlisting their support for charging for all parking. The analysis found, somewhat surprisingly, that about 81% of the city supplied parking in large lots and garages already requires payment of a fee. Because the impact on travel behavior of nominal parking charges on the remaining 19% of the parking spaces would be modest, the measure does not appear to be significant for air quality unless existing and new parking charges were to be increased substantially. MTC also compiled information from various cities that have explored alternative approaches to setting parking requirements for new developments, particularly those near transit.

FSM 5: Enhanced Housing Incentive Program/Station Access Program
This measure consists of two parts: 1) a strategy for increasing the funding for MTC's Housing Incentive Program (HIP) to attract more development near transit, and 2) an analysis of improved transit station access strategies, including station cars, bikes, and shuttles.

The funding strategy suggests pooling existing MTC, Air District, Congestion Management Agency and state funds, to arrive at an annual pool totaling $15 million dollars. The measure also presents strategies to better leverage other funding sources for housing near transit.

The transit access analysis evaluated opportunities for expanding three different access modes: use of a pool of shared station cars (preferably low emission vehicles), developing more bike pavilions and bike stations around transit, and expanding shuttles to BART, Caltrain, and ACE. These improvements would provide new mobility options for shorter distance access trips around stations, but emission benefits on a regional scale would be fairly limited, in the order of tenths or hundredths of a ton per day. If implemented, the measure could also include other technological elements, such as real time parking availability information, but does not attempt to attribute emission benefits to such elements.

Potential Episodic Measures

Reduced High Speed Travel. As discussed above, this measure would obtain emission reductions by limiting freeway travel speeds to the posted speed limit. With the episodic approach, extra CHP enforcement would be instituted only on the 6 to 7 Spare the Air days during the year. The same questions about the potential emission benefits apply as above.

Limiting Use of 1981 and Older Cars. The Bay Area has some 350,000 cars that are 1981 or older, and which contribute high levels of emissions due to their less stringent emission control systems. The proposed concept would be to have the owners of these cars not drive their cars when notified of Spare the Air days, either voluntarily or in response to certain incentives. Because of the large amount of emissions these cars produce--between 30 tons per day (NOx) and 57 tons per day (VOC)--even a partial participation of owners could yield significant emission benefits. The fact that the program would produce more VOC than NOx reductions would be a positive feature in terms of the Bay Area's ozone control strategy. This approach would also be much less costly than acquiring the vehicles under the Air District's existing older vehicle scrappage program. An essential first step would be to survey vehicle owners to determine whether a voluntary program would be successful, or whether monetary or other types of incentives would be required for an effective program. The survey would also be designed to determine the extent to which low income owners of these vehicles might be adversely affected and to design possible remedies.

Employee Telecommuting. Employers can make a contribution to emission reductions on Spare the Air days by enabling some of their employees to work from home. Currently, employers in the Spare the Air network simply agree to notify their employees of an upcoming Spare the Air day. There are probably a number of employees who could work at home on Spare the Air days, if allowed to do so by their employers. This episodic measure could be performed as a voluntary employer initiative, or alternatively, the regional agencies could seek a a change in state law, which prevents local agencies from imposing trip reduction requirements on employers, to require that businesses make this option available to employees whose work could be performed at home. The legislation could be controversial, but the impact on business would be mitigated by the few Spare the Air days on which this option would be invoked. Emission benefits are difficult to calculate, until there is a better estimate of the potential number of employees who could participate. In 2002, 2000 employers with one million employees participated in the voluntary Spare the Air program.

Free Transit. A number of areas (e.g. Vancouver, Kansas City, St Louis, New Jersey, Portland, Dallas) have experimented with free transit on Spare the Air Days, some for lengthy periods and some for very short periods. Some programs have attracted ridership increases, but it is often difficult to show that these are people who switched from driving as opposed to frequent transit users who decided to ride the bus or train that day because of the free fare. Given the extensive Bay Area transit network, such a program is worth exploring, and if implemented regionwide should be evaluated both from a ridership perspective and an emissions perspective. The funding needed would be approximately equivalent to the $1.5 million in passenger fares collected on a daily basis. Raising bridge tolls on Spare the Air days has been suggested as one source, which itself would function as an episodic control measure to discourage auto use.

Table 1 shows some of the key parameters for the measures that have been evaluated to date.

Recommendations/Next Steps
Given the analysis to date, we recommend that the following approach should be pursued.

FSM 1-Particulate Traps. New particulate traps currently undergoing certification tests with CARB could lower particulates and NOx from diesel buses. MTC will evaluate funding opportunities for these devices in future programming cycles.

FSM 2 Update HOV Master Plan. While the emissions analysis shows HOV lanes do have some benefits, the effect of HOV lane expansion on regional emissions is best analyzed in the "baseline" emissions inventory, and not as a separate TCM. The HOV Plan adopted by MTC in February, 2003 will help guide long term HOV expansion in the Regional Transportation Plan.

FSM 3-Freeway High Speed Travel. The results of the initial analysis are inconclusive, but further investigation into emission factors of vehicles traveling at speeds above the posted speed limit should continue. If the results of this work warrant, an initial step could be to advise motorists to adhere to the posted speed limits on Spare the Air public messages.

FSM 5-Housing Incentive Program. A $15 million dollar annual target (up from the current $9 million) could be achieved by combining funding from MTC, the Air District, CMAs and state funds, such as the new Affordable Housing Bonds (Proposition 46 which passed in November) and other state funding programs. Additionally, MTC will actively work with the potential funding partners to create this pool of funds for HIP.

FSM 5-Transit Station Access. Car sharing agencies and transit operators are most directly involved in further expansion of this concept, and MTC would facilitate further work by those agencies. Bike access station improvements do not involve large amounts of funding and would be eligible for TDA Article 3 and CMA funding. MTC, the Air District, and transit operators should assess more stable funding sources as a way to expand successful transit shuttle services.

Episodic-Avoid driving older vehicles on Spare the Air days. Because of the large potential tonnages involved, further development of this measure is warranted. MTC will work with the Air District to conduct a survey of owners of older vehicles and assess the feasibility of voluntary versus incentive type programs. The survey will also address the impacts on low income vehicle owners. If the survey results are promising, an initial voluntary phase of the program would be developed for the 2003 ozone season.

Episodic Telecommuting Option. MTC and the Air District would work with Bay Area employers during the 2003 ozone season to explore a voluntary telecommuting initiative, and may, at a future time, seek modifications to existing state law to require employers to identify and extend to certain employees the opportunity to work from home on Spare the Air days.

Episodic-Free Transit. The follow up for this measure would be to develop a demonstration program for one or more transit operators and identify funding. The results of the demonstration would be closely monitored to determine the potential for broader application. The Air District is currently considering funding a program for the Livermore Amador Valley Transit system (LAVTA).

TABLE 1
Transportation Strategy Summary Table

	Description	Emission Benefits	Cost	Notes
FSM 1	Particulate Traps for new Urban Buses	.01 tons per day of particulate matter	$16.8 million	Accomplished through replacement/repower bus program
FSM 3	Lower freeway speeds for cars to posted limits; lower for trucks to 55 mph	Cars: VOC = 0.4-2.8 tpd NOx = 0.9-1.9 tpd	$90 - $100K per year for 6-7 days of added CHP enforcement	Costs are for an episodic program, which would be most cost-effective version of this FSM
FSM 4	Parking Management Incentive Program for cities	Unknown, but probably limited at modest parking rates	Assume $500 incentive per converted space to paid parking = $9.5 million	
FSM 5	Transit Station Access Improvements -Station cars -Bikes -Shuttles	0.2 tpd of VOC or NOx	Stations Cars: - $15m to $48m capital, depending on technology - $5m per year operations Bikes: - $3.9m capital - $80k to $100k per year operations Shuttles: - $2.5m - $4.0 million per year on a contract basis	Cost based on: - Station Cars: 1,000 car program - Bikes: 1,800 new bike access trips to transit - Shuttles: 6 new routes to BART and Caltrain

TABLE 1 (Cont'd)

Episodic	Emission Benefits	Cost	Notes
Limit use of 1981 and older cars	VOC: Some portion of 56 tpd NOx: Some portion of 30 tpd	- Assume 10% participation x 7 days x 2 trips x $3 per trip avoided = $1.5 million per year - Assume administrative cost of $125K per year	Costs based on incentive program which provides free transit pass to owner of older vehicle to make trip on transit
Employee Telecommuting	Potentially significant – up to 3 tpd VOC and NOx with 5% employee participation	Some productivity costs to employers	Emission benefits would depend on number of Bay Area employees who would be identified as eligible telecommuters
Free Transit	Assume 10% increase in daily transit riders VOC: 0.5 tpd NOx: 0.7 tpd	$9 - $10.5m per year for 6-7 Spare the Air days	Evaluation of program would be essential to identify actual number of new riders/emission reductions.

II. Further Study Measure 1
Particulate Traps on Urban Buses

Background
The *2001 Ozone Attainment Plan* identifies various control strategies for further study. Comments received during the public outreach indicated a concern with the health effects of particulate matter (PM) emissions from urban diesel buses. This concern was most strongly voiced in the urban areas with the densest transit service. While particulate matter is not one of the pollutants that lead to ozone, the Further Study Measure was intended to outline strategies that might help accelerate the reduction of PM from Bay Area transit buses.

There are two general strategies that have been considered.

> Replacement of Buses. Buses have a twelve-year optimum service life and are scheduled for replacement some time after they reach this life. Turnover of the bus fleet will generally result in new vehicles entering service with the newest and cleanest engines. Replacement of a typical urban bus will cost about $365,000. A bus with a newer engine will typically lower PM emissions by 0.58 grams/mile of service.

> Repowered Buses. This term means that rather than replacing the whole bus, only the engine is replaced. This saves the transit operator money while extending the useful life of the bus. Repowering will also reduce emissions because the newest engines will be installed. The additional advantage of repowering is that more engines can be replaced, compared to a program that replaces the entire bus and costs more. The average re-powering cost is about $100,000 per bus.

Regional Benefit
Clearly there will be a regional net reduction in PM with repowering, as a larger number of engines are affected and a greater PM reduction will result.

In response to the California Air Resources Board's (CARB) new Urban Bus Transit Rule that addressed bus particulate emissions, MTC proposed the use of Federal Transit Administration (FTA) formula funds (Section 5307) to accelerate the turnover of the Bay Area's bus fleet engines to less polluting, newer versions. While CNG was an option for transit operators, all of the Bay Area transit operators that are located in one of the two federal urbanized areas in which MTC has administrative responsibility for the formula funds decided in favor of using improved diesel engines

MTC generally programs three years of FTA Section 5307 funds in each programming cycle. The first two years are committed, but the third year remains open so that adjustments can be made to accommodate more urgent capital needs and to program unforeseen or emergency project needs. Emergency projects receive the highest priority for funding. MTC anticipated a significant capital need relating to the Air Resources Board Bus Transit Rule that required operators meet specific average fleet emissions standards. Working with the Bay Area operators, MTC determined that PM retrofits and repowers met the criteria to receive the highest priority for capital funding. MTC identified approximately $17 million in federal the FYs 2001-02 and 2002-03 funds for use in repowering. To fund these projects, MTC deferred other capital needs deemed less significant to FY 2003-04.

As a result of this effort the reduction of PM emissions was in fact accelerated significantly.

Emission Calculation
The emission benefits can be calculated as the difference in PM if all the money was used to purchase new buses versus the PM reductions from repowering a greater number of buses.

Net Benefit: Appendix A shows that the repowering strategy resulted in a net PM reduction of **3.6 tons per year**.

Future Opportunities
Looking into the future, even greater PM reductions may be possible. There are new particulate traps being tested by several Bay Area transit operators that, if proven to be effective and certified by the California Air Resources Board, could provide significant additional PM and NOx reductions from the urban bus fleet. These particulate filters could be used on buses for model year 1994 and newer. An additional advantage is that the devices would also reduce NOx from diesel buses by significant amounts (see Attachment B for technical description).

To capitalize on this opportunity, the transit operators would need to determine that the devices are free of any significant operational problems, and MTC would need to identify additional funding for purchase and installation of the devices.

III. Further Study Measure 2
Update HOV Master Plan

Further Study Measure 2 updates MTC's High Occupancy Vehicle (HOV) Lane Master Plan, which is documented in a separate report, and assesses the air quality impacts of various HOV lane configurations with and without express bus service. The larger HOV Master Plan report reviews current HOV lane performance, assesses overall deficiencies and gaps in the HOV lane system, and makes recommendations for additional lanes and operational strategies. The HOV lane master plan report also covers certain specific topics listed below:

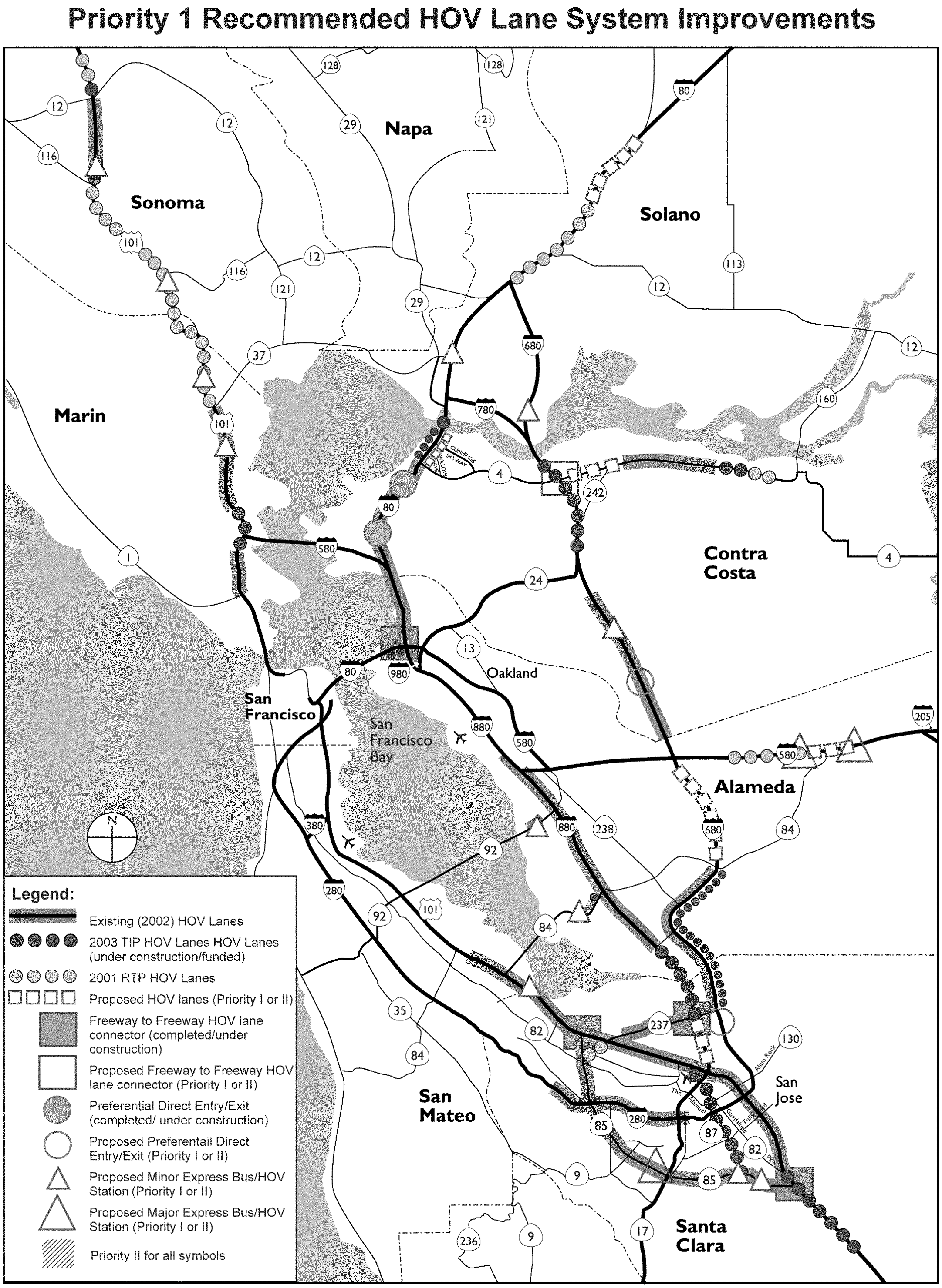
- Summarizes the results of a vehicle license plate and user survey to evaluate carpooler characteristics
- Assesses potential for spot use of some freeway shoulders for express buses
- Assesses potential for additional HOV lane freeway-to-freeway connectors
- Reviews strategies for improved HOV lane enforcement
- Assesses opportunities for High Occupancy Toll lanes whereby single occupant vehicles could "buy in" to underutilized HOV lanes.
- Updates costs for recommended HOV lane improvements and HOV and express bus support facilities (e.g. park and ride, bus stops/shelters, etc.)

The Further Study Measure component of the HOV Master Plan update focuses on the air quality implications of the HOV Master Plan and also provides summary comparisons of the transportation performance of different HOV lane configurations.

<u>Transportation and Air Quality Impact Assessment</u>
The HOV lane analysis first defined a set of discrete HOV lane and express bus configurations which were then analyzed using MTC's travel demand forecast model.

1. *2001 TIP/Basecase***.** Includes all HOV lanes that are programmed for funding in the 2001 TIP
2. *Mixed Flow***.** Converts all HOV lanes in the 2001 TIP to mixed flow lanes which would be open to all traffic.
3. *HOV Master Plan*. This alternative includes all HOV lanes in the 20 year Regional Transportation Plan, plus additional lanes (Priority 1) recommended for expansion (see Figure 1).
4. *HOV Lanes with Increased Occupancy Requirements.* All lanes in HOV Master Plan would have 3+ occupancy requirements.
5. *HOV Master Plan with Express Bus.* This alternative consists of the HOV Master Plan with an expanded regional express bus system operating on HOV lanes
6. *Conversion of Mixed Flow to HOV with Express Bus.* Converts selected mixed flow lanes to HOV while maintaining current occupancy requirements (generally 2+, except for I-80) and operates express bus on these lanes (See Figure 2).

Figure 1


Priority 1 Recommended HOV Lane System Improvements
Sonoma
Napa
Solano
Marin
Contra Costa
Oakland
San Francisco
San Francisco Bay
Alameda
San Mateo
San Jose
Santa Clara
Legend:
Existing (2002) HOV Lanes
2003 TIP HOV Lanes HOV Lanes (under construction/funded)
2001 RTP HOV Lanes
Proposed HOV lanes (Priority I or II)
Freeway to Freeway HOV lane connector (completed/under construction)
Proposed Freeway to Freeway HOV lane connector (Priority I or II)
Preferential Direct Entry/Exit (completed/ under construction)
Proposed Preferentail Direct Entry/Exit (Priority I or II)
Proposed Minor Express Bus/HOV Station (Priority I or II)
Proposed Major Express Bus/HOV Station (Priority I or II)
Priority II for all symbols

Priority 1 Recommended HOV Lane System Improvements: Santa Clara County

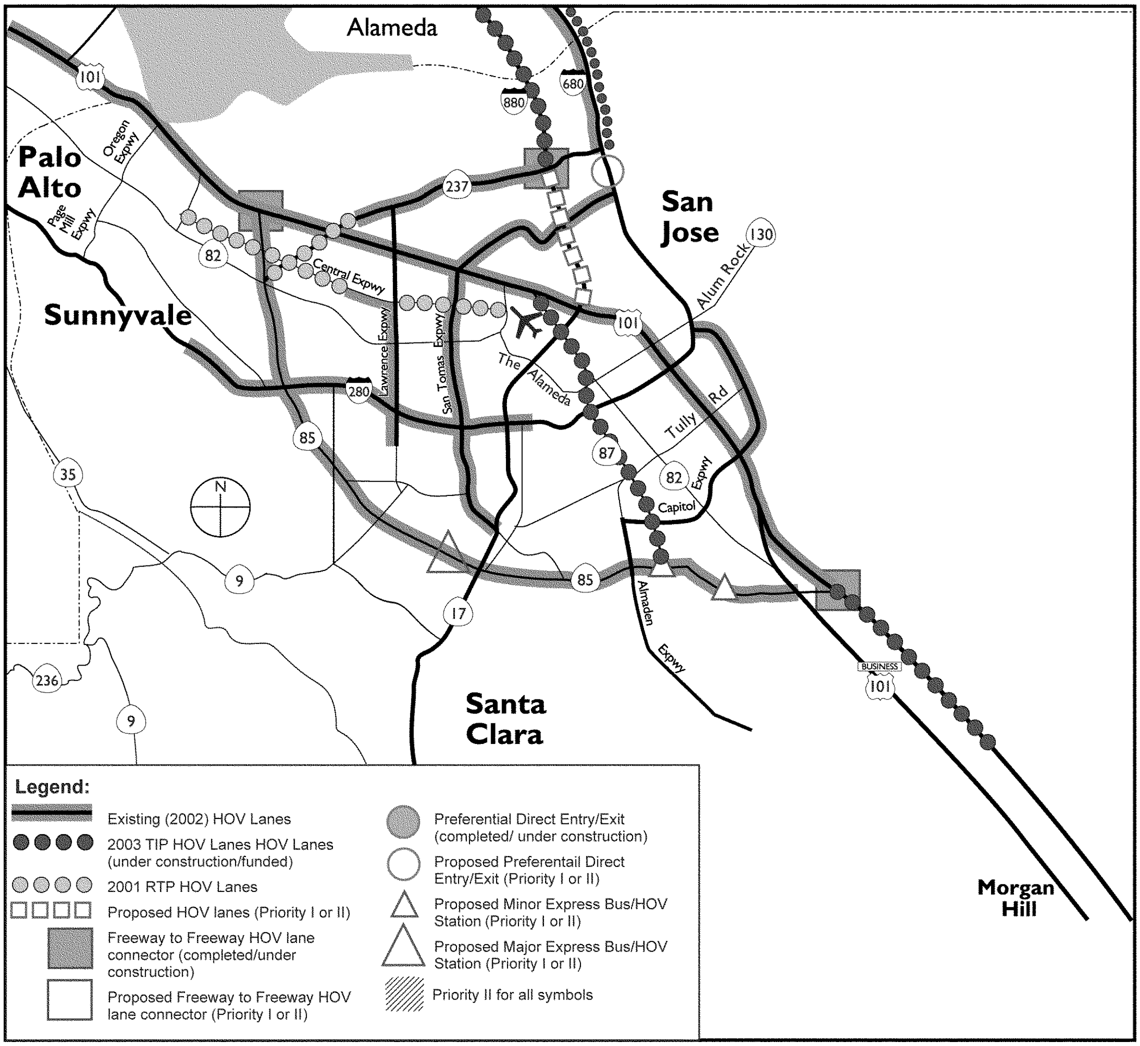
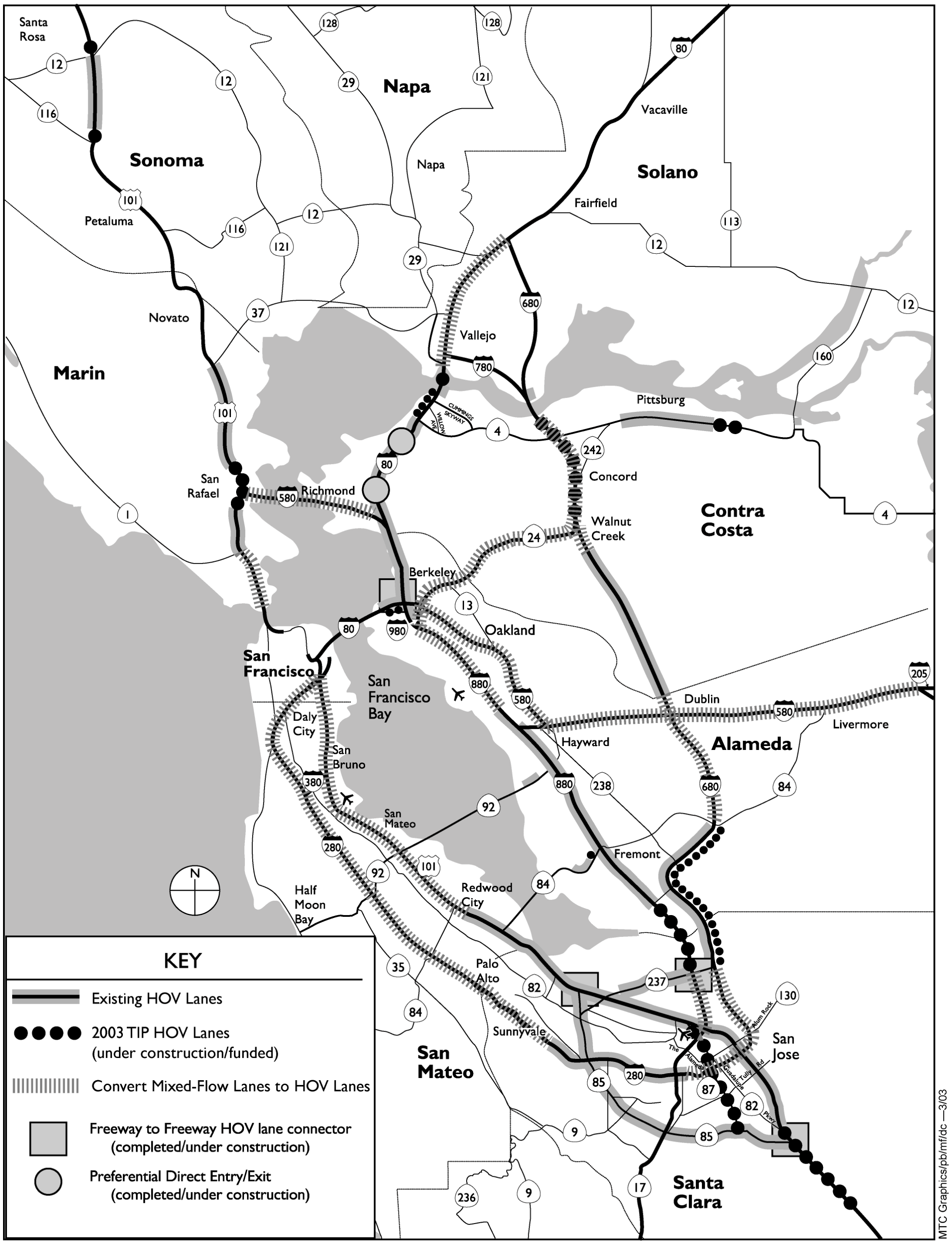


Figure 2

HOV Master Plan Alternative 6 – Conversion of Select Mixed Flow Lanes to HOV Lanes



Methodology

MTC coded the HOV lane configurations defined above into the MTC travel demand model's transportation network for 2010 and developed travel forecasts for each configuration. The travel demand forecast model estimates carpool and transit use based on travel time, cost, and other factors. Outputs from the travel model affecting regional emissions include total vehicle miles of travel (VMT), speeds in the mixed flow and carpool lanes (freeway speeds), and total vehicle trips (trip starts).

To analyze regional motor vehicle emissions, the latest version of the California Air Resources Board's (CARB) EMFAC model was employed. The current model provides updated emission rates for various vehicles (passenger cars, trucks and buses) based on their age, engine characteristics and other factors. In the EMFAC model, the emission rates are combined with travel forecast model outputs of vehicle activity to calculate total mobile source emissions.

The following steps were performed to calculate mobile source emission inventories in this study.

> *Step 1*: The MTC travel demand model was run for all HOV alternatives to generate total vehicle trips, vehicle miles of travel (VMT) and vehicle miles of travel by speed range.
> *Step 2:* The travel demand model outputs were processed to produce three variables by county:
> - a) VMT
> - b) number of trips/engine starts
> - c) hourly speed distributions
>
> *Step 3:* For each county and HOV alternative, the three variables were incorporated into the EMFAC input file using the "What If Scenario" (WIS) generator tool.
> *Step 4:* Results for ROG and NOx were tabulated (along with travel characteristic data) by county and summed.

Transportation Results

Travel activity forecasts were analyzed for five major statistics, which are illustrated in the Figures below:
1. Vehicle miles of travel (Figure 3)
2. Number of carpools (Figure 4)
3. Number of transit riders (Figure 5)
4. Average freeway speed (Figure 6)
5. Vehicle Hours of Travel (Figure 7)

Overall differences in any measures at the regional level are small, since the HOV system and express buses operating on HOV lanes are just one component of a larger regional transportation network.

- Freeways with HOV configurations perform better than freeways where all lanes are available to general traffic.
- Carpool use (combined 2+ and 3+) is lowest for the mixed flow lane alternative and highest for the conversion of some existing lanes to HOV with express bus service. The difference in total carpools between the conversion alternative and the recommended HOV Master Plan is about 17,000 daily carpool trips (about a 2% difference).
- Among HOV alternatives, vehicle hours of delay are highest when some existing mixed flow lanes are converted to HOV (with express bus), and lowest with the proposed HOV Master Plan.
- Restricting HOV lanes in the Master Plan to 3 or greater person carpools causes increases in vehicle delays, since the 2+ carpools are shifted back into the crowded mixed flow lanes increased congestion in these lanes.
- Regional transit ridership is highest when some existing mixed flow lanes are converted to HOV with express bus service. The difference in transit ridership between this alternative and the HOV Master Plan is about 6,600 daily transit trips in 2010 (a 0 .4% increase).

<u>Other Transportation Issues</u>

A question has been raised in the past about whether HOV lanes may induce more vehicular traffic. Answering this question involves a qualitative response, as there are not analytical ways to address it, certainly not within MTC's travel model framework. Answering this question further requires a common understanding of what is meant by induced traffic, and secondly an understanding of the long term relationships between freeway demand and capacity. Most aspects of individual or induced travel, including time of day shifts, routes shifts, and shifts in modal shares are directly handled in the MTC forecasts. That is, some of the travel on new HOV facilities that is perceived as "new" would actually be traffic that has shifted as described above. A second type of induced traffic relates to trips that may be created and use freeways that would otherwise not have been made at all save for the addition of new freeway capacity. Since most Bay Area freeway corridors will be congested in the future, due to projected growth in regional population and jobs, the peak direction commute period will have little available capacity that could induce individuals to take extra trips—with or without HOV lanes. In the current Bay Area HOV system all HOV lanes are converted to mixed flow for the non commute period. Off peak (generally non work) trips show lower sensitivity to time and cost variables in traditional models; therefore, the availability of new capacity would be a weak incentive to make extra off peak trips, at best.

<u>Air Quality Results</u>

The key air quality questions that were addressed in this study are:

1. What are the differences in regional emissions (ROG and NOx), comparing the HOV system with freeways where the same number of lanes are open to all traffic?

2. Which HOV lane configurations provide the lowest emission reductions?

The first question is addressed by comparing the 2001 TIP (Basecase) with its HOV lanes to the same freeway network with no HOV lanes. The second question is addressed by comparing emissions among the various HOV lane/express bus configurations. Figures 8 and 9 illustrate these comparisons.

Emissions with and without HOV lanes. Converting all HOV lanes in the TIP to mixed flow would produce about 1.3 more tons daily of ROG and 0.9 more tons of NOx.. Put another way, HOV lanes would reduce regional ROG by about 1% and NOx by about 0.4%.

Emissions from various HOV configurations. All HOV lane configurations show lower emissions than the Mixed Flow alternative. The HOV lane Master Plan with express buses produces the lowest amount of ROG followed by the HOV Master Plan; however, the difference is only about 0.2 tons per day (0.2% regionally). The HOV lane configuration with the lowest NOx is the conversion of some mixed flow lanes to HOV with express bus service. The lower NOx emissions result from slowing traffic down in the mixed flow lanes, as they become more congested (a consequence that emanates from the relationship between NOx and average speed).

<u>Conclusion</u>

Like most TCMs HOV lanes reduce both ROG and NOx. The region's air quality control strategy has historically focused on obtaining more ROG reduction then NOx as the most efficient path to attainment of the federal ozone standard. Therefore, the net impact of HOV lanes on emissions is mixed due to this simultaneous reduction of both pollutants.

For a number of years, HOV lane emission benefits in regional air quality plans have been accounted for in the "baseline" emission inventory for the SIP. This is the preferred approach, rather than identifying HOV lanes as a separate TCM, since it provides for a more holistic analysis of the transportation system and is consistent with the way the transportation air quality "conformity" analysis has been carried out under the regulations promulgated by the US Environmental Protection Agency.

Figure 3

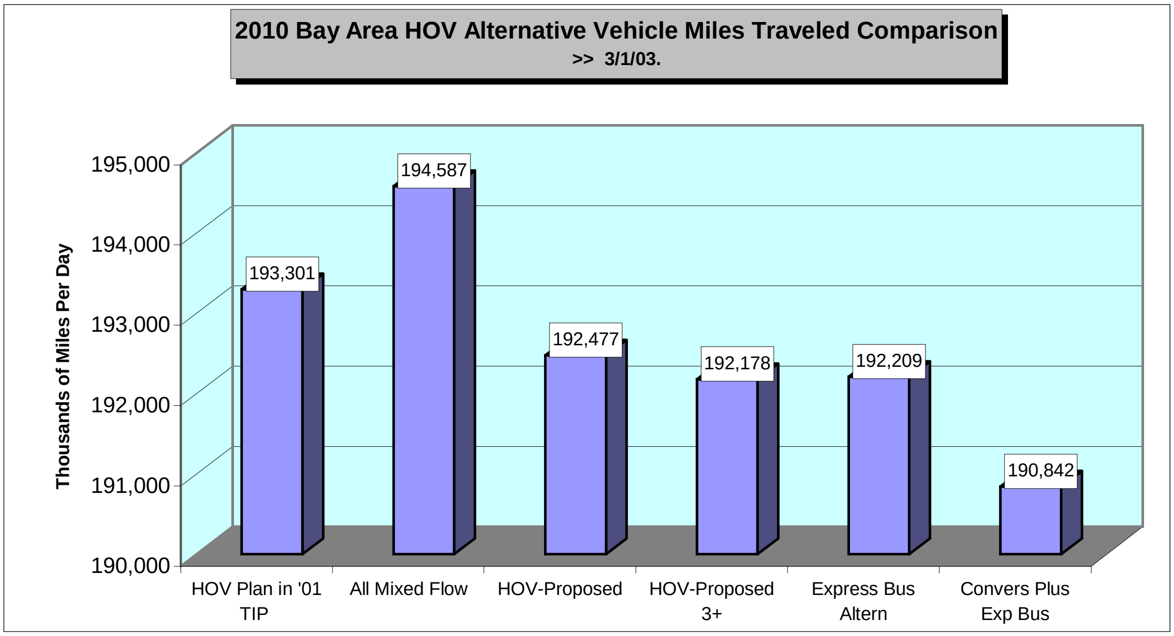


Figure 4

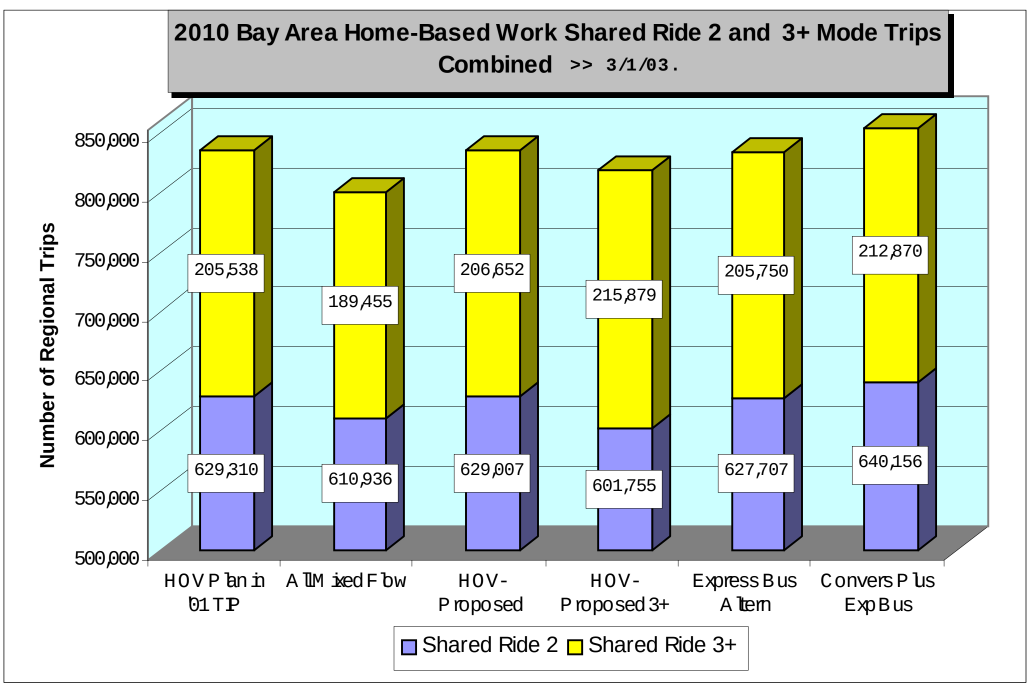


Figure 5

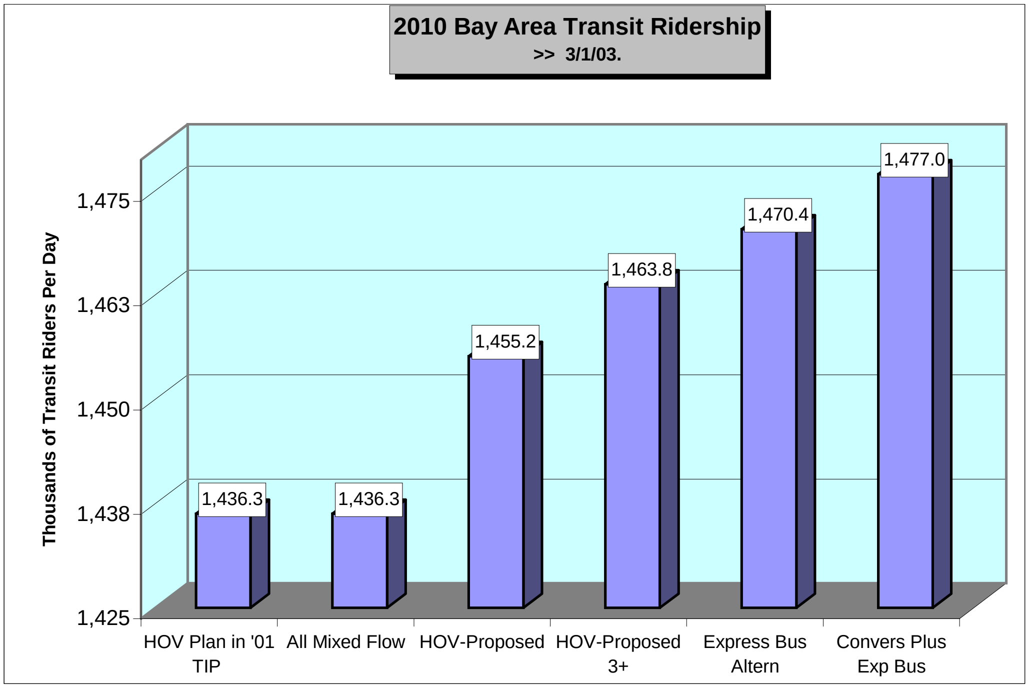


Figure 6

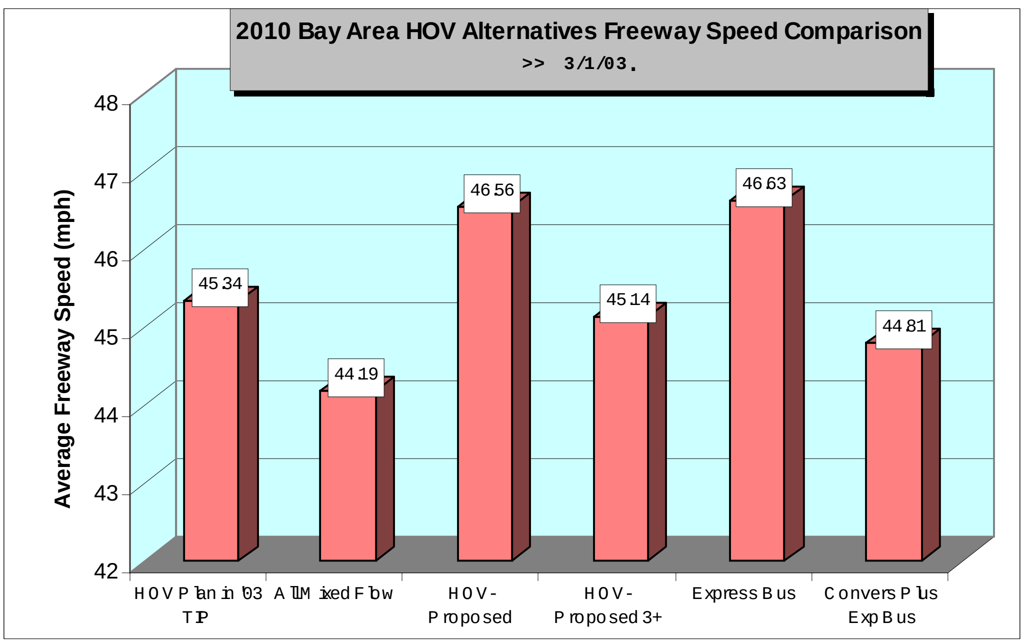


Figure 7

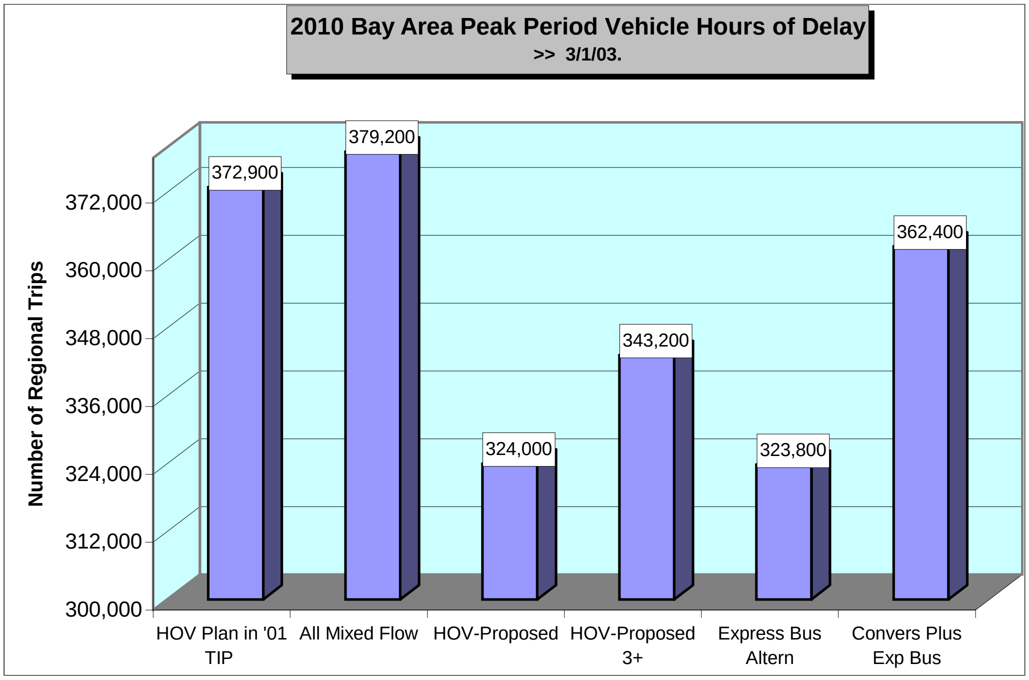


Figure 8

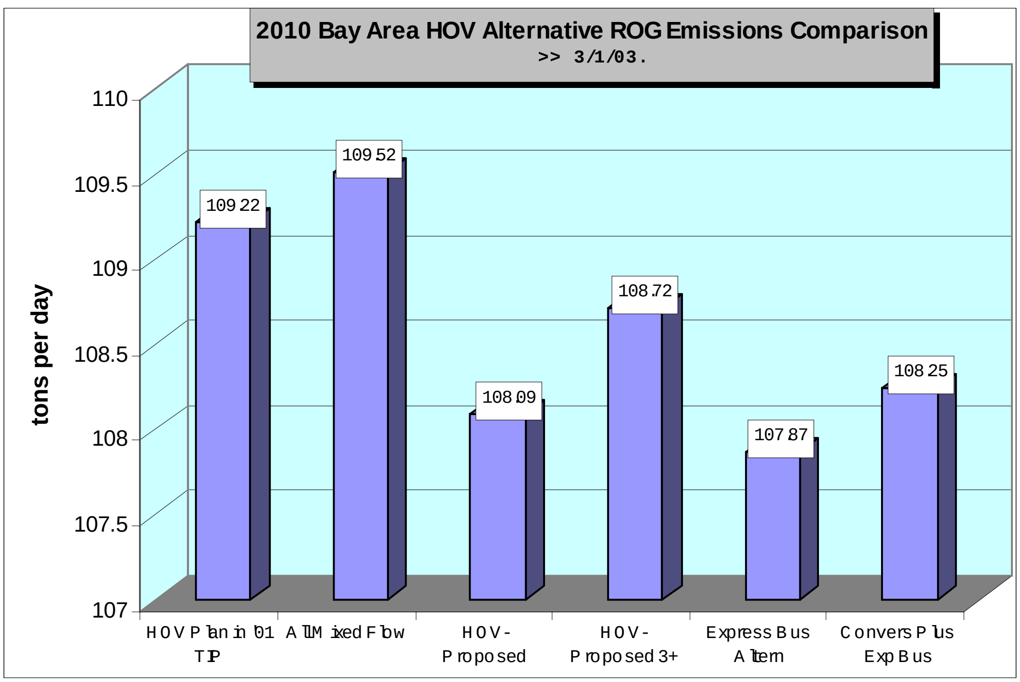
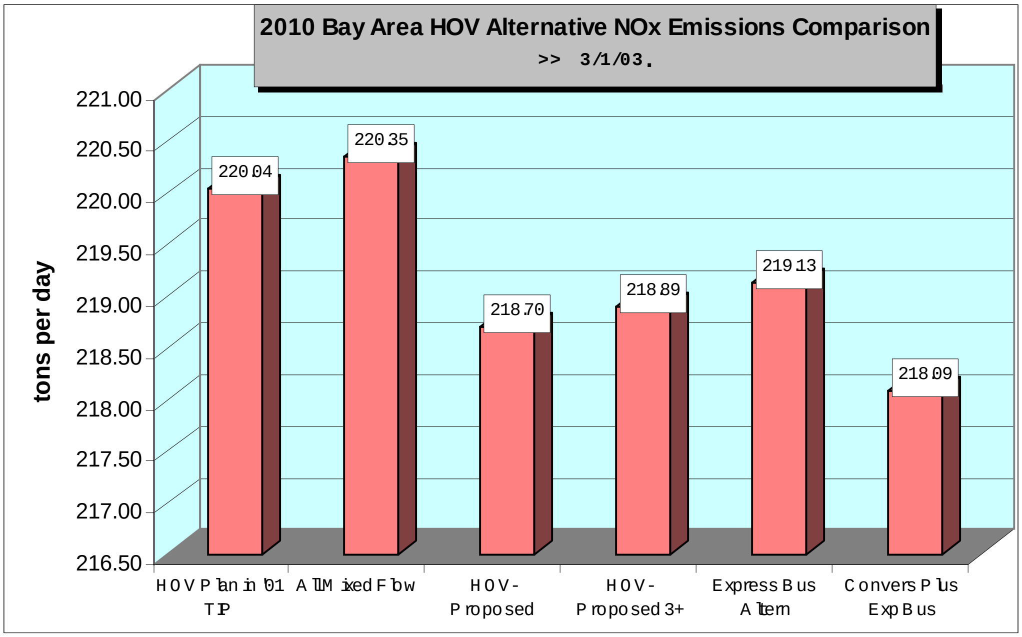


Figure 9



2010 Bay Area HOV Alternative NOx Emissions Comparison
>> 3/1/03.
tons per day
221.00
220.50
220.00
219.50
219.00
218.50
218.00
217.50
217.00
216.50
220.04
220.35
218.70
218.89
219.13
218.09
HOV Plan in '01 TIP
All Mixed Flow
HOV-Proposed
HOV-Proposed 3+
Express Bus Altern
Convers Plus Exp Bus

Other Corridor Analysis (I-680 Sunol Grade HOV Alternatives)

In a similar vein to the regional HOV alternatives, a detailed traffic simulation model was employed in the I-680 Sunol Grade corridor to evaluate emissions with different HOV configurations. This corridor is useful because: 1) there is an existing calibrated traffic simulation model, and 2) the corridor does not have parallel routes for diversion of traffic from the freeway.

The I-680 Corridor from I-580 in Alameda County to Calaveras Boulevard in Milpitas has experienced significant congestion in the southbound direction during the morning commute period. The interim I-680 southbound HOV lane project was opened to traffic in December 2002 from Route 84 to Route 237 and does not include ramp metering; the permanent southbound and northbound HOV lanes are currently being designed.

The I-680 corridor freeway operations model (called FREQ 12) allows for a detailed traffic assessment of the various HOV lane options during the A.M peak four-hour period (i.e., 5 a.m. to 9 a.m.), which is also the critical period for generation of pollutants (ROG and NOx) that contribute to ozone. Modeling of HOV operation was conducted for year 2005. FREQ12 is a traffic simulation models and was used to assess the effects of the following five mixed flow and HOV scenarios on the I-680 corridor, which largely duplicate the types of regional HOV lane configurations analyzed above.

> **S0**. *No Build.* Three mixed flow lanes in each direction
> **S1**. *Mixed Flow.* Four mixed flow lanes in each direction (no HOV lanes or ramp metering)
> **2a**. *Planned HOV.* A single 2+ HOV lane and three mixed flow lanes in each direction without ramp metering,
> **2b-41**. *Planned HOV plus ramp metering.* A single 2+ HOV lane and three mixed flow lanes in each direction with optimized ramp metering along the corridor
> **S3**. *Planned HOV with 3+ Occupancy.* A single 3+ HOV lane with three mixed flow lanes in each direction (no ramp metering),
> **S4**. *2 HOV lanes in peak direction.* A reversible 2+ HOV lane so that there are two HOV lanes in the peak direction and always three mixed flow lanes in each direction (no ramp metering)

The air quality burden is assessed for the four HOV scenarios by using emission factors of EMFAC2000 to convert FREQ traffic outputs to vehicular emissions of Reactive Organic Gases (ROG) and Oxides of Nitrogen (NOx).

Air Quality Results

Table 1 summarizes the key comparison between emissions for the various scenarios. The amount of running emissions for each alternative is estimated by multiplying the total travel distance with the emission rates (in grams) corresponding to the average running speed (combined HOV and mixed flow lanes) of the freeway. The results in Table 1 are converted from grams to kilograms (454 grams per pound, 908,000 grams per ton; 908 kilograms per ton).

It is not possible to simply compare total emissions between alternatives, because certain alternatives are more efficient at accommodating travel in the corridor over the four hour morning peak, and thus produce more VMT (in the other alternatives, the VMT that is not accommodated in the four hour peak will occur in the off peak). Thus, the most useful comparison of the air quality benefits of the individual alternatives is to compare emissions on a *per passenger mile served* basis.

Table 1
I-680 Freeway Running Exhaust and Running Loss Emissions (Kilograms)

Scenario		Mixed Flow Lanes		HOV Lanes		Freeway Total				
		ROG	NOx	ROG	NOx	ROG	NOx	KPM	ROG/KPM	NOx/KPM
1998	Baseline	486	464			486	464	421.4	1.15	1.10
2005	S0	438	557			438	557	450.9	0.97	1.24
2005	S1	446	630			446	630	539.0	0.83	1.17
2005	S2a	256	497	41	128	297	625	649.6	0.46	0.96
2005	S2b	147	686	41	128	188	815	672.1	0.28	1.21
2005	S2b-4l	170	696			170	696	621.5	0.27	1.12
2005	S3	390	552	11	51	401	603	523.7	0.77	1.15
2005	S4	256	497	38	135	294	632	649.9	0.45	0.97

S0: No build (three mixed flow lanes in each direction)
S1: Four mixed flow lanes in each direction (no HOV lanes or ramp metering),
S2a: A single 2+ HOV lane and three mixed flow lanes in each direction without ramp metering,
S2b: A single 2+ HOV lane and three mixed flow lanes in each direction with optimized ramp metering along the corridor
S2b-4l: Same as S2b, but analyzed as four mixed flow lanes with ramp-metering.
S3: A single 3+ HOV lane with three mixed flow lanes in each direction (no ramp metering),
S4: A reversible 2+ HOV lane so that there are two HOV lanes in the peak direction and always three mixed flow lanes in each direction (no ramp metering)
ROG: Reactive Organic Gases
NO_X: Oxides of Nitrogen
ROG/KPM: ROG (Kg) per Thousand Passenger Miles Served
NOx/KPM: NOx (Kg) per Thousand Passenger Miles Served
Source: TJKM Transportation Consultants (2002)

1) Compared to the No Build alternative (**S0**--3 mixed flow lanes in either direction), adding a new 2+ HOV lane reduces ROG emissions by 32% (**2a**) to 61% (**2b—41**) and increases NOx by 35% to 61%-due to higher running speeds overall. However, on a per passenger mile served basis, the ROG reductions are even greater, and the NOx reductions are equivalent to or less than the No Build alternative.

2) Compared to adding mixed flow lanes (**S1**--4 mixed flow lanes in either direction), adding a new 2+ HOV lane reduces ROG by 33% (**2a**) to 62% (**2b-41**) and reduces NOx by 1% (**2a**) or increases it by (10%) (**2b-41**). However, on a per passenger mile served basis, the ROG reductions are even greater, and the NOx reductions are both greater for 2a and 2b-41.

3) 2+ HOV lanes (**2a**) are more effective than 3+ lanes (**S3**) in reducing emissions Raising the HOV lane occupancy requirement to 3+ persons in a vehicle will shift 2+ carpools to the crowded mixed flow lanes, producing 35% more ROG than **2a**. Because of lower speeds overall in the corridor and the speed/emission relationship for NOx, there would be less NOx with 3+ HOVs than the 2+ HOVs (by 4%). However, on a per passenger mile served comparison, the 2+ HOV lanes will still outperform the 3+ HOV lanes for NOx.

4) Adding a second 2+ HOV lane in the peak direction (**S4**) has similar emission results to the single 2+ HOV lane alternative, except NOx emissions are slightly higher due to the faster travel speeds in the mixed flow lanes.

The results of the analysis show that HOV lanes can effectively reduce the amount of ROG emissions by increasing the running speed on the mixed flow lanes. The combined 2+HOV lane with ramp-metering results in the least amount of ROG for every thousand passengers-miles served. Without ramp-metering, 2+HOV lanes (**S2a** or **S4**) are the most effective in terms of the amount of NOx per thousand passenger-miles served.

It's noted that vehicle delays encountered on freeway on ramps will contribute to idling emissions. Idling emission factors associated with EMFAC2000 were not available for this analysis, and could affect the relative emission reduction results for the various alternatives described above. The extent of this effect is not known; however, the major focus of the investigation was on mainline freeway operations, and the analysis is supportable for this purpose.

The full analysis is also contained in a separate report, *Final Report-I-680 HOV Lanes Air Quality Analysis, February 2003.* This report also includes an analysis of the emission benefits of optimizing signal coordination in the Tri-Valley area of Dublin, Pleasanton and Livermore.

IV. Further Study Measure 3
Study Effects of High Speed Freeway Travel

Vehicles traveling on Bay Area freeways at speed above 65 miles per hour emit significantly more VOC (hydrocarbons) and NOx than cars traveling at speeds between 35 and 55 mph. The purpose of this study measure was to determine whether expanded enforcement of the posted speed limit for cars and trucks on freeways could help lower regional emissions of ozone precursors. This enforcement could be implemented on a daily or episodic basis; such as on Spare the Air days.

Using recent Caltrans speed monitoring data, MTC determined how much daily vehicle miles of travel on freeways is occurring in the higher speed ranges. This speed survey data, which was collected over a 24-hour period, shows that there are times of the day when there is a significant amount of travel at high speeds. MTC has worked with the California Air Resources Board (CARB) to develop appropriate emission factors for the higher speed ranges (based on EMFAC 2000).

Methodology

The analysis requires two pieces of information: 1) the amount of daily vehicle miles of travel occurring at high speeds, and 2) the vehicle emission factors for vehicles traveling at speeds above 65 miles per hour.

<u>Amount of Vehicle Miles of Travel (VMT) on Freeways at High Speeds</u>

MTC collected the most recent Caltrans speed survey data for different freeway locations in the Bay Area. A weighting methodology was then used to expand the speed survey data to account for travel on all freeways over the entire day. The expansion technique involved associating the freeway speed survey data with an "area type" (urban, suburban, rural, CBD) and then applying these area type speed characteristics to other parts of the Bay Area freeway system (MTC Techmemo 74: <u>San Francisco Bay Area State Highway System 1999-01 Traffic Volumes and Speed Monitoring Hourly Volumes-Revised</u>, date May 17, 2002). The daily VMT in the 2001 Ozone Attainment Plan for 2000 was used for the Bay Area total. About 60% of daily VMT takes place on the freeway system, or about 96 million daily vehicle miles of travel. Whereas the MTC travel model lumps all VMT above 65 miles per hour into one speed "bin", the Caltrans survey data allowed MTC to divide this VMT into discrete 5 mph speed bins above 65 mph.

Regionally, about 34% of the daily vehicle miles of travel on Bay Area freeways occur at speeds over 65 mph. The resulting distribution of daily VMT by speed range is shown in Table 1 and Figure 1.

Large "big rig" trucks produce a portion of the 96 million daily VMT, and a separate assumption was made for the distribution of truck VMT by speed range. This distribution reflects the fact that there are fewer trucks traveling at very high speeds, since the posted speed limit for big rigs is 55 mph.

Posted speed limits on freeways vary between 40 and 65 miles per hour. The CHP does not have the authority to enforce speeds lower than the posted limits, except in emergency situations for safety reasons. Changes in state legislation would be needed for this to occur.

Motor Vehicle Emission Factors for High Speeds

CARB's motor vehicle emission model, EMFAC, does not disaggregate emissions separately for speed ranges above 65 mph. Thus, to perform this analysis MTC asked CARB to develop "speed correction factors" for this speed regime. CARB estimated these factors using two different assumptions: 1) speed correction factors increase linearly above 65 mph, and 2) speed correction factors increase exponentially based on a statistical fitting of factors over the larger speed range of 10-65 mph. (See Figure 2 and 3).

Because of the high NOx emissions from diesel trucks and the impact of high speeds on these NOx emissions, CARB developed a separate set of high-speed emission factors for trucks.

Results

For cars, the emission reductions were somewhat lower than expected, based on prior versions of EMFAC with which MTC has worked. These results are displayed in Table 2.

Table 2
Emission Reductions for Passenger Cars
-Speeds Limited to 65 mph-
(tons per day, tpd)

Speed Correction Factor	**VOC Reductions (tpd)**	**NOx Reductions (tpd)**
Linear	1.0	0.9
Exponential	2.8	1.9

Note: Values apply to all Bay Area freeways and for a 24-hour period.

On the other hand, slowing down all big rig trucks to 55 mph could theoretically have a large impact on NOx, decreasing NOx by over 20 tons per day.

More Focused Analysis

The above results are based on slowing down cars and trucks on all Bay Area freeways over the entire 24-hour period to 65 mph (cars) and 55 mph (trucks). A more realistic estimate would incorporate the following considerations.

- Adjusting emissions based on actual posted speed limits, versus assuming a constant 65 mph speed limit
- Enforcing the speed limit for the morning hours only, which are the critical hours for pollutant generation
- Enforcing speed limits on the central Bay Area freeways only, where most of the freeway traffic occurs
- Focusing enforcement of truck speeds on the major truck routes

- Factoring in the effectiveness of enforcement, since no enforcement program will be 100% effective

Enforcement of speeds for passenger cars. Controlling vehicle emissions in the central portion of the Bay Area during the morning and early afternoon (until 1:00 pm) would address the most critical emissions and could be implemented at a lower enforcement cost. Generally, emissions generated in the urban core are blown eastward by the prevailing winds, and accumulate into the afternoons. Rising temperatures then act on the emissions generated earlier in the day to create ozone in Livermore and other eastern portions of the region.

Given the considerations above, a revised estimate was developed which focused on enforcement of the posted speed limits on the central Bay Area freeways, enforcement until 1:00 p.m., and a 75% enforcement effectiveness. The emission reductions would be less than shown in Table 2, and are shown in Table 3.

Table 3
Revised Emission Reductions for Passenger Cars
(tons per day, tpd)

Speed Correction Factor	**VOC Reductions (tpd)**	**NOx Reductions (tpd)**
Linear	0.4	0.5
Exponential	0.9	0.8

Enforcement of big rig speed limits on major truck routes. The major truck routes are I-80, I-880, and I-580. Enforcing truck speed limits on these routes (55 mph) would serve to control the majority of truck VMT on freeways in the region. NOx reductions for this more limited program would drop to about 4 tons per day (also assuming a 75% enforcement effectiveness).

Other Considerations

The actual benefit of enforcing the speed limit is somewhat difficult to determine, even after this analysis. At the most, there could be 1 to 3 tons per day of emission reductions, but a focused enforcement program would reduce this amount as discussed above. The primary issue concerns the need to pin down actual motor emission rates since the difference between using the linear curve and exponential curve to calculate emissions is significant. To further analyze this question, MTC obtained some additional information from UC researchers (Dr. Matthew Barth) on vehicle emission characteristics in Riverside County. The additional information is derived from UC Riverside's Comprehensive Modal Emissions Model (CMEM) and high speed emissions data from dyanmometer testing using the Modal Emission Cycle (MEC, also developed by UC Riverside researchers) weighted for a Riverside California fleet. This data is plotted in Figures 2 and 3.

The supplemental information suggests that the shape of the VOC curve may be nearer the exponential method, while it is inconclusive as to which NOx curve provides the best estimation. In addition to the potential magnitude of emission reduction that could be achieved by additional enforcement of posted speed limits, there are secondary concerns that relate to the ratio of VOC and NOx reductions. Due to the Bay Area's air chemistry, control measures have historically focused on VOC reductions at a higher rate than NOx, that is greater reductions in VOC will result in more expeditious attainment of the one hour ozone standard. As shown in Tables 2 and 3, this may not be the case, depending on which vehicle emission curve is used.

For truck speed enforcement, it is clear that the major reductions would be for NOx, and this may be even be counter productive in terms of achieving attainment as noted above. (although it would help with transport issues associated with the Central Valley's air quality). Also, with respect to the emission calculation, MTC is less certain as to the distribution of truck speeds on freeways as this data is not reported separately from passenger vehicles in the Caltrans survey.

A third area of concern relates to the types of vehicles traveling at speeds over 65 mph. The CARB emission factors are generalized factors for the entire fleet of vehicles in the Bay Area. However, if the vehicles traveling above 65 mph are predominately newer vehicles, the emissions would be less due to their more advanced emission control systems.

Having raised the points above, it does seem that the topic of high speed travel warrants further investigation, if for no other reason than to refine the motor vehicle emission inventories in the State. The first reason for refinement would be due to the relatively large amount of surveyed VMT occurring over 65 mph (an estimated 34% in the Bay Area) and the frequency of occurrence of some very high speeds on freeways. Emission factors currently in use may not fully capture these emissions. For example, assuming for purposes of discussion that the true emission rates are represented by the exponential curve for both HC and NOx, the calculated emissions at speeds above 65 mph would be an additional 4.33 tons/day of VOC and 2.88 tons/day of NOx in the regional mobile source emission inventory. This is in comparison to the current technique of using the 65 mph vehicle emission factor for the cumulative amount of VMT above 65 mph.

The last consideration has to do with developing an enforcement program and being able to claim emission credits in the SIP. If the actual higher speed emissions are not reflected in the original SIP inventory for motor vehicles, it is not possible to reduce them and claim credit, which is somewhat of a Catch 22. Therefore, all the air quality planning agencies would first need to agree on a revised protocol for calculating higher speed emissions, then include the emissions in the inventory, then offset the emissions with a an enforcement transportation control strategy.

This analysis has highlighted several interesting areas for further investigation to determine if there are real emission benefits from lower freeway speeds. Since the amount of travel above 65 mph appears significant from Caltrans surveys, this should provide added impetus to conducting further research. For the Bay Area, the research would also need to address the question as to whether the reductions of VOC and NOx from lowering speeds are in the right proportion. Any new work would also need to be coupled with some further traffic surveys that could be used to determine the age of vehicles traveling at higher speeds.

Table 1
Adjusted Freeway Regional VMT by Speed Class, Year 2000

Speed (mph)	BAR/CARB* 5-9AM & 4-8PM VMT	% of VMT	9AM-4PM & 8-12PM VMT	% of VMT	Total 24 Hour VMT	% of VMT
>86	343,018	1%	294,925	1%	683,547	1%
81-85	1,096,984	2%	1,066,313	2%	2,276,245	2%
76-80	2,110,300	5%	2,330,267	5%	4,653,361	5%
71-75	4,454,987	10%	5,540,259	12%	10,387,309	11%
66-70	5,675,973	12%	7,873,088	17%	14,166,289	15%
36-65	27,532,637	60%	27,998,604	60%	57,497,069	60%
00-35	4,678,691	10%	1,489,007	3%	6,168,324	6%
Total	**45,892,589**	**100%**	**46,592,464**	**100%**	**95,832,143**	**100%**
>56**	**28,856,153**	**63%**	**37,181,108**	**80%**	**69,081,836**	**72%**
>61***	**20,173,055**	**44%**	**26,171,989**	**56%**	**48,513,611**	**51%**

* Bureau of Automotive Repair/California Air Resources Board

**For speed stratifications >56 use VMT percentages for each category

***For speed stratifications >61 use VMT percentages for each category

Note:

1) For MTC Model results the highway assignment results exclude intrazonal trips

2) For BAR/CARB VMT, it is assumed that the VMT distribution by speed class is similar to the MTC Model

Figure 1
Adjusted Freeway Regional VMT by Speed Class
Year 2000

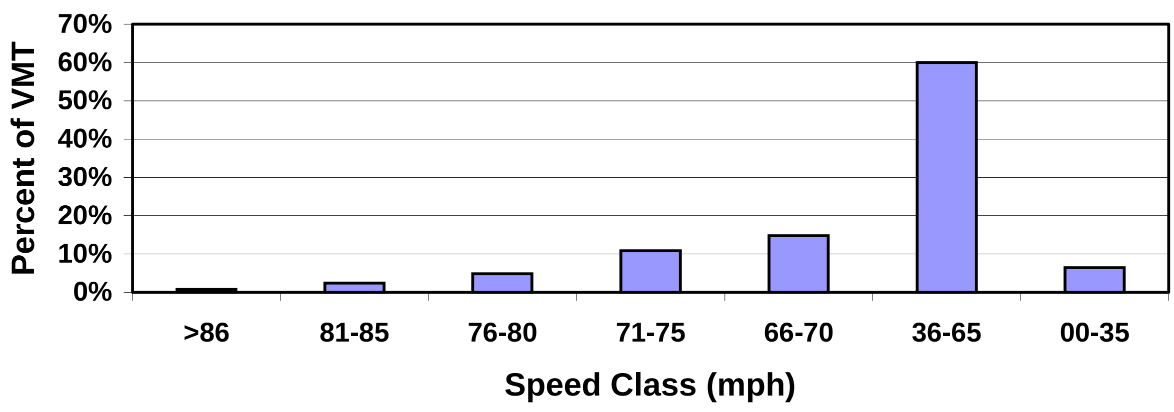
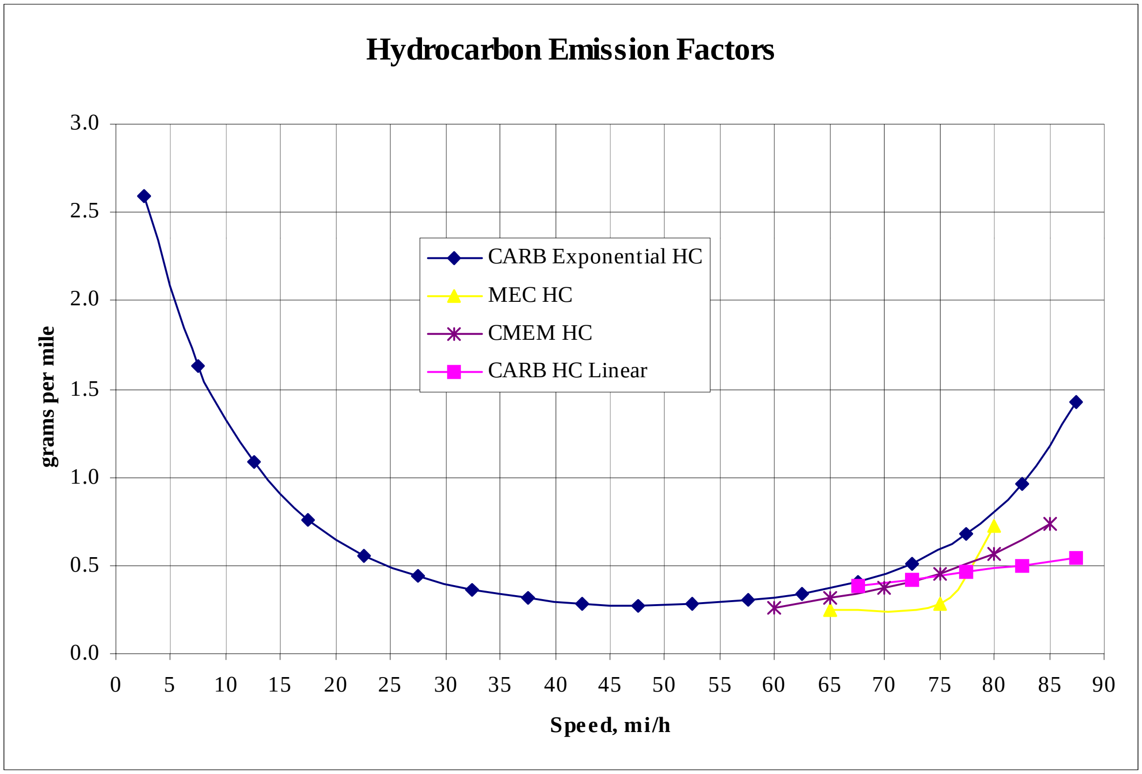
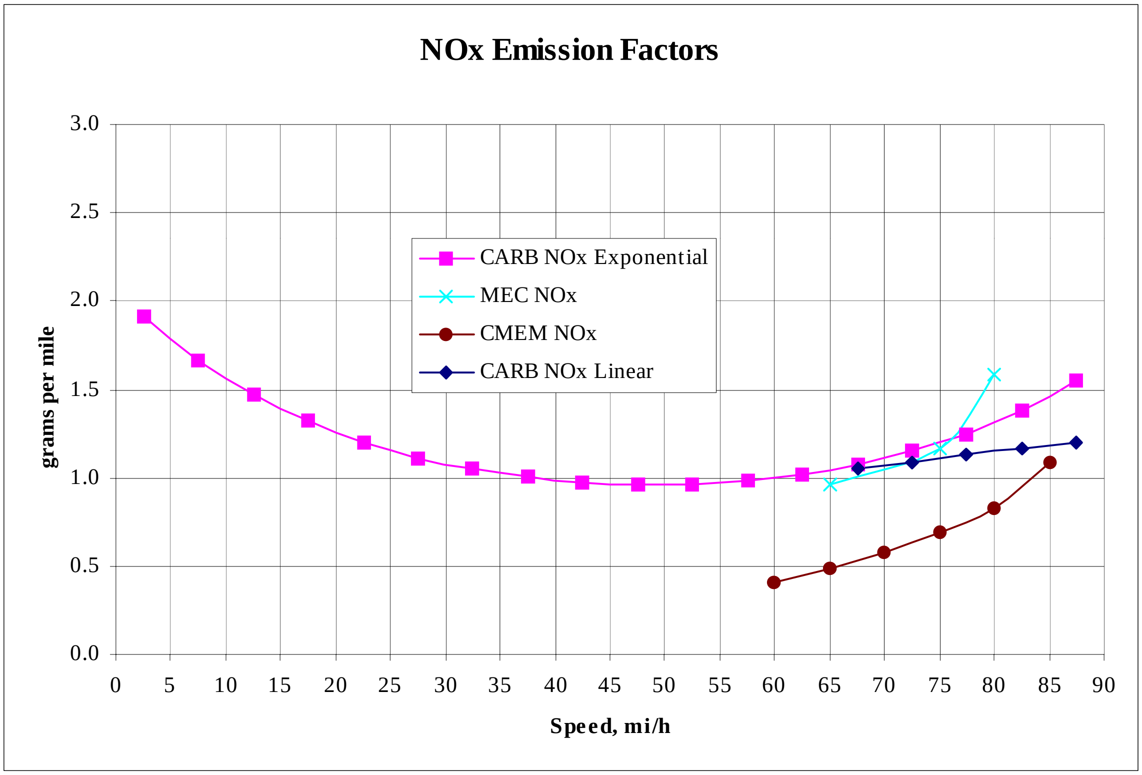


Figure 2



Hydrocarbon Emission Factors
3.0
2.5
2.0
1.5
1.0
0.5
0.0
grams per mile
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90
Speed, mi/h
CARB Exponential HC
MEC HC
CMEM HC
CARB HC Linear

Figure 3


NOx Emission Factors
3.0
2.5
2.0
1.5
1.0
0.5
0.0
grams per mile
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Speed, mi/h
CARB NOx Exponential
MEC NOx
CMEM NOx
CARB NOx Linear

V. Further Study Measure 4
Parking Management Incentive Program

Introduction

The purpose of this Further Study Measure in the 2001 Ozone Attainment Plan was to

> *"conduct a study to evaluate the feasibility of an incentive program for cities that lower parking requirements near transit stations and convert free public parking spaces to paid spaces"*

Municipalities provide free parking for a number of reasons: to ease parking problems in certain neighborhoods, to attract shoppers to downtown shopping and employment districts, and to provide space for their employees and for citizens attending public meetings (e.g., at town meetings, and public offices, etc.). Like private employers, municipalities are often unwilling to charge for the parking they provide, except in limited circumstances. However, if greater application of pricing concepts to transportation facilities and services is to be seriously pursued in the future, local governments can provide an example by charging for the use of their parking spaces. New parking fees could also provide funds for expanding local transportation services and other public needs.

It is common for cities to charge for parking in metered spaces on streets, usually to create turnover for shoppers. Charging for parking in larger municipal parking lots and structures is less uniform, except in the larger downtowns where parking is scarce, and it is not uncommon to find fee lots operated by the city and by private firms.

In general, pricing municipal spaces could alter travel behavior in several ways:

- Drivers may forgo some discretionary trips
- Drivers may combine trips, making a single trip instead of two or more separate trips or may choose to carpool
- Drivers may avoid extra car moves, such as moving their car from one end of a large shopping center to another (these engine starts create additional emissions)
- People may choose a shuttle, bike, walk, or transit trip instead of driving and paying for parking

While paying out of pocket for the use of the transportation system and its various components is not new, recent polls indicate that the public may be warming up to the idea. MTC's recent Bay Crossings Study found solid support for congestion pricing on the Bay bridges, i.e., charging higher tolls in the peak period than the off peak. Agencies planning new HOV lanes in the I-680 Sunol Grade corridor are considering allowing non-carpools into these lanes if they pay. Also BART has begun charging for up to 25% of their parking spaces for those who want to reserve a spot. Formerly free spots will now cost $63.00 per month under the initial phase of the project (some stations will maintain free permit parking for carpools). Finally, paying for parking is already generally accepted by the public in a variety of venues, such as airports, concerts, sports events, and in congested downtown areas.

The first part of this analysis examines how much existing municipal space is free and how much is paid. The analysis of municipal parking supply involves a relatively small portion of the parking in the region, as the bulk of the region's parking supply is in private hands (Bay Area employers and retailers). We also concentrated on parking associated with larger lots and structures, rather than on-street metered parking (this would have been a much larger task, and most jurisdictions do not have readily available data).

MTC also explored the extent to which local governments modify parking requirements for new developments, particularly those located near transit and for affordable housing projects. The cost of constructing parking can be a major impediment to the construction of housing, especially for affordable housing and in-fill projects. Parking requirements for some populations (low-income and seniors, for example) are substantially lower than standard parking rates due to low vehicle ownership rates. Reduced parking requirements in certain situations would encourage the use of alternative modes and support investments in transit, while making it easier to construct housing that serves these types of development.

Opportunities and Constraints

In terms of opportunities,

- Parking shortages are prevalent (and likely increasing) in a number of downtown areas, and cities are considering how to address these shortages. Thus the topic of charging for parking is ripe and could be addressed on a more global basis by these cities.
- To the extent that land shortages require new parking to be constructed in structures, cities will likely need to charge for this parking to pay for the higher construction cost.
- If municipal lots are already constructed and paid for, charging for parking would generate new revenues for local government. These new revenues would themselves have some potential to affect emissions if used to fund downtown shuttles, pedestrian and bike connections between the downtown and nearby transit, or between transit and the downtown area. Parking fees could also fund residential parking programs.
- New municipal lots could also help businesses expand if these businesses need to convert some of their existing parking to office or retail space. If the employees parked in municipal fee lots, there would be incentives to use alternative commute modes.

- Cities planning transit oriented development (TOD) near transit stations may have opportunities to create joint parking facilities that could be charged and shared by the new development near the transit station.

On the constraint side,

- Charging for parking may have the unintended consequence of forcing parking into nearby residential neighborhoods (if on street parking is not regulated with residential parking permit programs).
- If all cities in competition for retail sales in the same market area do not charge for parking, jurisdictions that provide free parking could have an economic advantage over cities that charge for their parking.

Survey Methodology and Results

The primary activity conducted as part of this Further Study Measure was a survey of Bay Area municipal parking supply. The survey resulted in detailed parking information by jurisdiction. In addition, the survey attempted to determine whether or not there are innovative parking policies being developed by cities that apply to off street parking requirements for new development (residential, commercial, etc.).

The survey covered the following topics:

1. Municipal parking:
    - Determine the amount of parking spaces provided by municipalities in major surface lots or garages
    - Assess the amount and locations where parking is free and priced
    - Explore trends and future plans for construction of additional parking and payment policies

2. Off street parking requirements for new developments
    - Determine the amount of parking required for developments by different municipalities, including for both residential and commercial developments
    - Investigate the extent of customized parking requirements for developments that serve populations that are known to have lower levels of auto ownership
    - Explore whether parking requirements are modified in areas of high quality transit service

An MTC intern conducted a phone survey from June – August 2002 to collect information. Calls were made to the public works, traffic engineers, redevelopment, and/or planning departments of all cities and counties in the Bay Area. Parking supply information was also obtained from Caltrans (Park and Ride), BART, and Caltrain. Where available, information was downloaded from web pages. Follow-up calls were made where information provided was incomplete or additional questions arose. In addition, information was collected from major private parking providers in San Francisco, San Jose, and Oakland. Data was then entered into a database and analyzed by MTC staff. The database excludes on-street parking, employer provided parking, private parking at shopping centers, and privately run parking outside of San Francisco, Oakland and San Jose.

While information on new and innovative off street parking requirements for new developments was solicited, this information was more difficult to collect since parking decisions are often made on a case-by-case basis.

Findings Related to Municipal Parking Charges:

1. The survey collected data on 150,000 parking spaces in the region in surface lots and parking structures of all kinds (cities, BART, Caltrans Park and Ride).
2. 81% of municipal spaces in lots and parking structures charge for parking.
3. A larger proportion of free parking is found in outlying suburbs of the Bay Area compared to the cities around the Bay.
4. A majority of paid parking is found in the downtown districts of San Francisco, Oakland, and San Jose.
5. Caltrans provides over 5,000 free spaces in 52 park and ride lots.
6. Caltrain has almost 10,000 spaces. Most of those spaces are paid spaces at a price of $1.50 per day.
7. BART provides roughly 40,000 spaces.
8. BART's new parking policy charges patrons to reserve space and apply to 25% of its spaces starting in December 2002.

Tables 1 and 2 summarize the public parking supply information gathered by county

9. Table 1 includes all parking spaces, i.e., cities, transit operators, Caltrans
10. Table 2 includes only municipal parking.

Both tables include public parking operated by private firms in San Francisco, San Jose, and Oakland

Table 1: Bay Area Public Parking Supply

	Parking Lot Spaces		Garage Spaces		Total Spaces		Percent	
County	**Free**	**Paid**	**Free**	**Paid**	**Free**	**Paid**	**Free**	**Paid**
Alameda^	2,624	4,492	1,020	6,939	20,343	11,431	64%	36%
Contra Costa	1,998	1,126	1,607		20,608	1,126	95%	5%
Marin	2,086	1,246			2,086	1,246	63%	37%
Napa	709		869		1,578		100%	0%
San Francisco^*		20,342		23,187	-	43,570	0%	100%
San Mateo	762	376			5,182	2,902	64%	36%
Santa Clara^	3,534	9,334	2,068	10,005	5,602	23,837	19%	81%
Solano	3,138				3,138		100%	0%
Sonoma	3,762	3,284			3,762	3,284	53%	47%
Totals	**18,613**	**40,200**	**5,564**	**40,131**	**62,299**	**87,396**	**42%**	**58%**

*Does not include BART lots
^Includes private parking in San Francisco, San Jose, and Oakland

Table 2: City Provided Parking Supply

	Parking Lot Spaces		Garage Spaces		Total Spaces		Percent	
County	**Free**	**Paid**	**Free**	**Paid**	**Free**	**Paid**	**Free**	**Paid**
Alameda^	1,420	4,492	1,020	6,939	2,440	11,431	18%	82%
Contra Costa	1,298	1,126	1,607		2,905	1,126	72%	28%
Marin	806	1,246			806	1,246	39%	61%
Napa	709		869		1,578		100%	0%
San Francisco^		20,342		23,187		43,529	0%	100%
San Mateo	120	376			120	376	24%	76%
Santa Clara^	3,494	9,334	2,068	10,005	5,562	19,339	22%	78%
Solano	2,410				2,410		100%	0%
Sonoma	3,052	3,284			3,052	3,284	48%	52%
Totals	**13,309**	**40,200**	**5,564**	**40,131**	**18,873**	**80,331**	**19%**	**81%**

^Includes private parking in San Francisco, San Jose, and Oakland

Findings Related to Innovative Practices for Off Street Parking Requirements for New Development

The survey did not find any evidence that there is a major sea change underway in how local governments think about off street parking requirements. However, there are numerous examples of reduced or modified parking requirements for various types of development around the Bay Area. Lending institutions appear to be a driving factor in terms of how much parking must be provided, while cities are showing increased flexibility. Banks and other lenders typically desire large amounts of parking to ensure the economic viability of the property for which they are making a loan, even in cases where cities permit lower parking requirements. The survey showed that decisions to reduce parking requirements for new developments are typically made on a case-by-case basis, and are the result of negotiations between city staff, neighbors, developers, and lenders. Some cities have Transit Oriented Development (TOD) overlay districts that clarify reduced parking requirements. Examples of jurisdictions that have recently modified off street parking requirements are listed below:

Mountain View

1. Over 1000 new housing units constructed near transit in the last few years as a part of their award-winning Integrated Transit-Oriented Development. Reduced parking requirements for retail and 1-bedroom developments in the downtown area near Caltrain and VTA light rail.
2. Provision for shared parking at The Crossings TOD project near Caltrain station where condominium residents (only one assigned space per unit) share additional parking with Caltrain riders.
3. A Transit Overlay Zone, done in conjunction with three separate precise plans, encourages increased floor areas ratios for commercial development within 2000 feet of transit.
4. Allows for reduced parking requirements of up to 5% when EcoPasses [year-long transit passes] are purchased for residents/employees near transit.

Milpitas

1. New Midtown specific plan being prepared for TOD development near light rail and future BART station
2. TOD overlay district permits 20% parking reductions and possible shared parking arrangements
3. Retail parking requirements reduced my 20% in this zone

Corte Madera

The new Housing Element in the city's General Plan will reduce parking requirements for affordable housing

San Mateo

Recently approved senior housing project had reduced parking requirements of 23 spaces for 18 units

Gilroy

New general plan calls for reduced parking requirements for TOD and affordable development to be studied further in new Downtown Specific Plan

Pinole

Pinole Ridge residential project recently approved with a 15% reduction in minimum parking requirements

San Bruno
The Crossing residential project recently approved with a 15% reduction in minimum parking requirements

Oakland
TOD at Fruitvale BART will reduce residential parking requirements from 1.0-2.0 spaces per unit to 0.5 spaces per unit. No parking will be required for 39,000 feet of retail. City approved a transit village zoning overlay ordinance to allow maximum flexibility

Pleasant Hill
TOD near BART station reduced minimum parking requirements for office/retail from 5 spaces per1000 square feet to 3.3 spaces for office and 4.0 spaces for retail. Residential rates were cut from 1.75 spaces per unit to 1.35. So far, the lower rates provide more than adequate parking supply.

San Jose
Allows for reduced parking requirements of up to 5% when EcoPasses [year-long transit passes] are purchased for residents/employees near transit.

Berkeley
The Gaia Building in the downtown area was allowed to reduce its parking requirements by housing City Carshare vehicles in its garage.

Possible Incentives/Disincentives
Like land use planning and decision-making, parking policies are locally controlled and determined. From time to time, some transit advocacy groups have suggested that MTC condition the distributions of certain transportation funds on whether local jurisdictions have enacted commute alternative programs and development policies relating to parking supply or parking charges. MTC has not pursued this course of action because there is no nexus to the statutory authority granted to MTC by the Legislature and because local governments would see this as an infringement on their decision making process and could seek legislative remedies to curtail MTC's ability to impose such funding conditions.

Two types of initiatives might have some impact on municipal parking and off street parking for new developments.

Incentives
Incentives could provide some encouragement to local governments who may be considering charging for their parking space. Incentives would function in a manner similar to MTC's Housing Incentive Program, where cities can "earn" additional transportation funding by providing transit oriented development at higher than normal densities near transit stations. In the case of municipal parking, funds could be earned by converting existing free municipal spaces to paid spaces. MTC could identify a funding amount available to local jurisdictions for each public parking space converted from free

to paid. This funding could be provided in a variety of forms, as determined by the local jurisdiction:

- Congestion Management and Air Quality (CMAQ) funds for shuttles to transit, real time parking information technologies, streetscapes, bike paths, car sharing programs etc. to enhance parking and the downtown environment.
- Surface Transportation Program (STP) funds for pavement rehabilitation or local transit rehabilitation
- Traffic Engineers Technical Assistance Program (TETAP) funds to evaluate alternative policies for charging for parking.

Fees

For parking spaces provided as part of new development in a city, an option would be to create a regional or local parking impact fee that would be used to mitigate regional and local traffic impacts associated with the new parking. Since the fee would be assessed per space, the fee would be lower for new developments that provide lower amounts of parking. The developer could choose to pass the fee on to those who use the parking, thereby encouraging people to use alternative forms of transportation. Legislation would be needed to provide the authority for MTC or Congestion Management Agencies to assess such an impact fee.

Air Quality Benefits

The emission benefits from charging for municipal parking are very difficult to identify, since the number of parkers affected is not known, nor the level of the fee that might be set for the space that is currently free. People living close to the municipal space would tend to have more options for avoiding parking than those further away, particularly if the general area is not well served by transit. Fees high enough to reduce vehicle trips may be unacceptable to local governments, particularly if the purpose of the parking space is to attract economic activity to a downtown area.

Summary

Given the desire to instill greater pricing signals in the transportation system as a means to affect travel behavior, charging for all municipal parking, no matter how small a fee, would help to move this concept forward. To the extent local jurisdictions realize additional revenues, financial benefits would accrue to the jurisdiction, and these revenues could be used for other local transportation purposes.

VI. Further Study Measure 5
Enhanced Housing Incentive/Station Access Program

This study measure includes two distinct parts:

1) Defining a concept for pooling public funds to attract more housing near transit, and
2) Developing new transit station access components to expand transit use.

Part 1, the funding portion, describes a strategy for combining existing funding programs under the control of separate agencies (e.g., MTC, Air District, HUD, State, etc.) to attract more municipal and developer interest in transit-oriented housing. The funding analysis would also explore new federal, state, and local revenue sources that collectively could contribute to an annual incentive program approaching or exceeding $15 million per year. By comparison, the size of MTC's current Housing Incentive Program (HIP) is $9 million per year. Finally, the funding analysis also reviews new ways to create incentives within the framework of the overall MTC.

Part 2, the station access component, discusses new concepts for enlarging the overall transit market as well as reducing emissions associated with drive alone access to transit stations. These concepts include the use of station cars (cars that transit riders can use to and from transit stations), bike stations, and smart shuttles to transit. The analysis draws on new experience and examples of various innovative station access concepts that are or have been tested in the Bay Area or other regions. Station cars and car sharing programs would allow transit users access to cars for shorter trips made to and from transit stations, while the bicycle and shuttle programs would focus on ways to increase the transit access mode share of these modes as well. For each strategy costs and emission reductions are also estimated.

Expand Funding for the Housing Incentive Program

The purpose behind MTC's HIP is to provide a regional funding incentive program to foster more development of compact, transit-oriented housing. Jurisdictions participating in the HIP program receive transportation funds, which may be used in a manner consistent with the goals of the MTC's Transportation for Livable Communities (TLC) neighborhood capital grant program. Eligible projects include transportation-related improvements such as streetscapes, transit villages, bicycle facilities and pedestrian plazas. The transportation project may be located anywhere within the local jurisdiction. To be eligible to receive transportation funds via HIP, housing projects must meet the following guidelines:

- For a local jurisdiction to apply for HIP funds, there must be a proposed housing project in the initial planning stages. If a project has received all planning permits, then it will not be considered for the incentive funds. Incentive funds are intended to help move housing developments at transit stations from a concept phase to construction in a timely fashion. Project sponsors will be asked to explain the planning status of housing projects identified on the one page application submitted.

- Eligible projects must be within 1/3 of a mile walk (1,800') from the center of the development site to a trunk line transit station. Eligible transit service is bus, ferry or rail transit with no more than a 15-minute headway during the peak period commute.

The density thresholds and award amounts are:

  - 25 units per acre: $1,000 per bedroom
  - 40 units per acre: $1,500 per bedroom
  - 60 units per acre: $2,000 per bedroom

  For all affordable units, an additional $500 per bedroom will be awarded.

- Since the HIP awards are federal funds, the standard local match of 11.5% must be provided

- A pedestrian path of travel from the center of the project to the transit stop must be provided and demonstrated on a site plan and project maps. This path must comply with the Americans with Disabilities Act.

- Mixed-use development is encouraged but not required.

- Transportation projects funded with the HIP award must be consistent with the goals of the TLC neighborhood capital grant program. Eligible projects include transportation-related improvements including streetscapes, transit villages, bicycle facilities, and pedestrian plazas. The transportation project may be located anywhere within the local jurisdiction. If a project is approved for funding, MTC will designate the appropriate funding source to individual projects based on program eligibility

Air District/MTC/CMA fund sources that could be pooled
There are numerous sources of funds that help support the creation of housing in the region, some of which are under the control of the Bay Area Air Quality Management District, the Metropolitan Transportation Commission, and the Association of Bay Area Government- the three co-lead agencies for air quality. The likely resources are combining the HIP program with some portion of the TFCA Program, other MTC fund sources, and perhaps, funding some planning activities or financial services provided through ABAG.

Each fund source is discussed briefly below. Integration of fund sources will require work between all of the affected agencies. For such an approach to work, one application cycle and one call for projects could be used to administer these funds. For the applicant, they would merely apply for and receive an incentive for providing transit-oriented housing. The relevant agencies would be responsible for assigning funds to projects and for working with sponsors after the award for obtaining the necessary information to meet their obligations. This approach is modeled after the Transportation for Livable Communities capital grant program. TLC is funded with Congestion Management and Air Quality (CMAQ) funds and Transportation Enhancement Activities (TEA) funds. Applicants to the TLC Capital program apply for funds through one process. MTC staff determine which fund source is most appropriate for the project. The project sponsor does not need to submit one application for CMAQ and/or one for TEA funds. Instead, the sponsor applies for a TLC grant. MTC staff handles the administrative process rather than placing additional burdens on project sponsors by having separate application processes for the TLC program. Through collaboration, the regional funding agencies could establish a similar process for interagency funds that are administered through a pooled incentive program.

Funds that could be pooled to achieve a $15 million annual funding level include:

<u>TLC County Shares (County Congestion Management Agencies)</u>
In addition to the $9 million MTC regional HIP program, the 2001 Regional Transportation Plan created a $9 million county TLC program. Although each county would determine how it wants to spend these funds, it is conceivable that one third of the funds could be used for the larger regional pool, assuming there would be HIP projects in these counties, for an additional $3 million.

<u>Transportation Fund For Clean Air (Air District)</u>
Smart Growth projects are eligible for the Bay Area Air Quality Management District's Transportation Fund for Clean Air (TFCA) funds. The Smart Growth funds and the Housing Incentive Program funds could be jointly administered and increase the overall size of the program. In the last cycle for TFCA, over $900,000 was awarded to four Smart Growth projects in the region. Pooling this money with MTC's $9 million HIP program would yield $10 million annually.

State Funds

1. <u>State Affordable Housing Bonds</u>
   Approved by voters in November 2002, Proposition 46 authorizes the state to issue $2.1 billion of general obligation bonds to fund 21 housing programs. While most of the funds will go into existing state programs, the proposition also creates a number of new programs with details to be established by subsequent legislation. This presents an opportunity to focus some of the state housing bond revenues into communities where Regional Transit Expansion Projects are planned. Program allocations of interest for Transit Oriented Development include:

Program Area	Amount
Multifamily Housing Programs (Language states this measure gives funding priority to projects in already developed areas and near existing public services. MTC could work with the HCD to ensure priority is given to projects along transit corridors.)	$1.11 Billion
Programs Within Measure Jobs-Housing Balance Program (details would be established by subsequent legislation) Building Equity and Growth in Neighborhoods. (Created by AB 1170 (Firebaugh) and funded through Prop 46)	 $100 Million $75 million

Program funds will be allocated over a three- to five- year period. The measure provides the Legislature broad authority to make future changes to the programs funded by the measure. MTC could work with the legislature to help target Bay Area housing resources to community areas around Regional transit Expansion stations.

2. State Department of Housing and Community Development
The HCD provides short-term loans for pre-development costs of projects to construct, rehabilitate, convert or preserve assisted housing, manufactured housing and mobile home parks. Priority is given in this program to developments in public transit corridors, or which preserve and acquire existing government-assisted rental homes.

3. State Tax Credit Allocation Committee
The State Tax Credit Allocation Committee administers tax credits for the construction of affordable rental housing throughout the state. The credits amount to an annual program of $50 million. Projects are awarded based on how well a projects fit different selection criteria. There are numerous categories in which to receive funds. It is a highly competitive program and typically a few points make the difference between a project that receives funding and one that does not. Currently, proximity to transit is a criterion in the overall ranking process under "Community Amenities." The criterion does not take into account transit frequency or the type of transit service available. MTC staff began discussions with the State Treasurer's Office to determine if the transit criteria can be modified for the 12 urban counties in the state. Modifications might include consideration for type of transit service, frequency of transit service, or density of housing. MTC staff is also

beginning discussions with other Metropolitan Planning Organizations about possible criteria revisions for the tax credit allocation process.

4. Caltrans' Community Based Transportation Planning Demonstration Grant Program
   The annual program totals about $3 million and supports livable community concepts and is aimed at long-term sustainable growth. Projects must have a component or objective related to transportation. Each project may not exceed $300,000.

Summary

Thus the assemblage of the various fund sources would be as shown in Table 1 below:

Table 1
Summary of Possible Sources to Increase the Size of HIP

Program	**Size of Fund**
Housing Incentive Program	$9,000,000
County HIP Program	$3,000,000
TFCA	$1,000,000
State Funds	$2,000,000
Total	$15,000,000

Other fund sources that might be pooled
There are various local, state and private sources that might be tapped to enlarge the funding pool, including the following:

Community Capital Investment Initiative (Bay Area Council/HUD)
There is also a possibility that the new Community Capital Investment Initiative could work collaboratively with the regional agencies to identify projects and areas for potential transit oriented development. The Community Capital Investment Initiative is a regional effort to attract private investment into the poorest neighborhoods in the Bay Area with market-based solutions and to support smart growth projects. Within this program, one category of funding, the Bay Area Smart Growth Fund, offers a potential partnership opportunity with the MTC Housing Incentive Program. The Smart Growth funds invests equity in real estate developments that can be commercially viable but are not yet sufficiently attractive to private developers. Working together, CCII and MTC staff could identify projects that have potential in transit oriented neighborhoods and make their funds available to help finance these projects. Public agencies could focus some of their resources in neighborhoods where CCII can bring developer interest and financial support. CCII and MTC will need to develop a strategy for this to occur.

Regional Gas Tax

MTC has the authority to place a gas tax on the ballot in the Bay Area for up to 10 cents for 20 years. AB 2181 (Dutra), Chapter 161 Statutes of 2002 amended this legislation to allow TLC/HIP type projects to be eligible for inclusion in the expenditure plan for the gas tax. Such a tax would need to be approved by 2/3 of the Bay Area voters. No date has been set to place such a measure on the ballot.

Moving Forward-Other Considerations

In addition to increasing the size of the funding incentive programs, there are other related steps that could be taken to maximize the benefits that could be achieved without additional funding. These tools will address the barriers often cited for transit-oriented development in the region. Three area topics are discussed below:

Tax-Increment Financing For Transit Oriented Development

Currently, local redevelopment agencies are able to use Tax-Increment Financing (TIF) in areas that are determined to be blighted as a tool to help strengthen and improve the area. This financing tool, coupled with a redevelopment agency's ability to assemble land helps them to achieve redevelopment objectives. The state could authorize local jurisdictions to use TIF powers in areas near rail facilities, ferry terminals, and rapid bus corridors for Transit-Oriented Development. This would require enacting legislation to use TIF around these facilities. Such a measure would help local agencies assemble land for development and may offer a financing tool to cover the higher costs of development.

ABAG Financial Services

The Association of Bay Area Governments offers a variety of financial services that help local jurisdictions and non-profits develop projects throughout the region. The financial products and services help reduce costs by pooling bond issues and spreading costs over a number of participants. This allows local jurisdictions and, in some cases, developers to reduce their financing costs and simplify the borrowing process. It is possible that ABAG, in collaboration with the other regional agencies, could focus these financial tools to help accelerate development in transit-oriented neighborhoods.

Improved Interagency Funding Coordination

There are numerous grant programs in the region that support the development of both housing and affordable housing in the region. Some grant programs are government sponsored and others are administered by private organizations. MTC, ABAG, and the Air District could work with other agencies that control these funds to provide a higher level of financial support for housing projects in transit-oriented neighborhoods.

The regional agencies could also work with other agencies to enable projects that are receiving Housing Incentive Program funds to also receive some preferential treatment through the scoring processes of these other agencies, such as the Department of Housing and Urban Development. For example, many programs award points to projects by attributes, and it is possible that projects receiving a Housing Incentive Program award from MTC could also be given additional points during the project selection process of the other agencies. Likewise, the HIP selection process could be modified to provide greater recognition of projects supported by other funding sources.

Finally, MTC could synchronize the "call for projects" for both the TLC Capital and the Housing Incentive Program with assistance programs such as the state tax credit programs for affordable housing. If developers can identify the HIP or TLC Capital funds in their application for tax credits, it could help these developers receive the credits or the grants needed to implement the housing project.

Preparation of Specific Plans as a way for Reducing Planning Hurdles for Transit Oriented Housing

Transit oriented development or mixed use, infill developments are not new forms of development, however, they often do not comply with standard general plans and zoning codes. Most traditional plans and zoning codes are typically oriented around separation of land uses and accommodation of private vehicles. Designing for transit oriented development that relies more on pedestrian and bicycle access to transit requires a different design approach and a different set of land use criteria. Further complicating matters, existing communities may not react favorably to new development projects with higher densities near transit or mixed uses if that is not familiar in the local area. Preliminary discussions with planning staff and developers reveal some common barriers to the creation of transit oriented and infill housing which include:

- Community resistance to infill projects or higher densities
- High cost for land assembly
- Zoning codes do not allow for mixed-use or compact, higher densities
- Many builders not familiar with mixed-use or attached housing models
- Uncertainty associated with the planning process
- Planning process takes longer in established communities with active community groups
- Higher lending costs due to perceived risk
- Higher construction costs to meet parking requirements
- Construction defect laws that make condominium and townhouse development more risky and less attractive to builders

Specific plans are a planning tool that can help expedite development and help local communities and developers plan for future growth. They can also play a key role in eliminating many of the variables mentioned briefly above. They may be as instrumental if not more instrumental than housing incentives for encouraging development around the transit system. The regional agencies could create a fund to help local agencies bear the cost of undertaking specific plans.

Specific plans also provide developers with important information about what is allowable within a certain area and provide greater certainty about the development process. Many of the issues that would normally emerge during the planning application process are addressed during the early development of a specific plan. If a Program EIR is adopted to fulfill a plan's California Environmental Quality Act obligation, this streamlines the processing of future projects by addressing environmental issues in advance of project applications.

Part 2. Improving Access to the Regional Transit System

The second part of Further Study Measure 5 focuses on station cars, bike stations and storage, and a regional shuttle program. These access improvements may increase transit ridership somewhat, and will affect emissions generated by trips to and from the individual transit stations in the region. Each modal section provides an overview of the station access concept, defines a program, and then evaluated the air quality benefits to be realized.

A. Station Cars

Shared cars at transit stations for the purposes of this paper will be called station cars. By integrating car sharing with public transit, there is a potential to increase the reach of the public transit system. Blending these two approaches is logical given the dispersed activity centers (work, shopping, educational facilities, housing, etc.), which surround the trunk transit systems. Because dispersed development patterns are difficult to serve with a fixed route public transit, greater flexibility and the ability to customize a trip are needed to serve today’s travel market.

Car sharing lots would be located at stations along the major transit lines for all types of public transit. Members would reserve their car via Internet, phone, or a handheld device such as a Palm Pilot. Once a car in reserved, the member would board the public transit system, arrive at their destination, leave the station, find their car, and drive away. It is not anticipated that a lot attendant will be necessary.

<u>Existing Car Sharing Programs in the Bay Area</u>

Rather than expand the roles and responsibilities for transit operators, it is envisioned that a station car program would involve partnerships between the region’s transit operators and several organizations in the Bay Area that are currently offering car sharing services. Car sharing participants join a club that offers access to a fleet of vehicles available for their use at any time. To become a member, individuals or businesses must pay a membership fee and complete a screening process (driving record check and credit check). Once approved, members may use any car in the program. Cars are spread throughout the region. For example, City CarShare lots are located throughout San Francisco, Oakland, Berkeley, and Palo Alto. Flexcar has a lot in Palo Alto and is planning future expansions in the region. Members check out cars through the Internet or phone reservation system for a period of time and then return them to the same location. Penalties are charged if a car is not returned by the designated time, and the car sharing organizations provide an alternative if no car is available to a member. Gas cards are provided if the user needs additional gas and the car sharing organization takes responsibility for regular upkeep of the car. Unlike renting a car, insurance, use, and gas costs are calculated based on the miles driven and the time a car is checked out. By spreading the fixed costs of car ownership across a broad spectrum of people and making the fixed costs variable, car sharing allows members to experience the benefits of auto ownership but without all of the fixed costs.

Based on the analysis of individual transit stations, a number of candidate stations were identified and are shown in Table 1. As a starting point, fifty-eight transit stations were identified as candidate locations for a station car program (refer to Table 1). The exact number of cars at each location will be determined by the demand. For example, in San Francisco some City CarShare lots have two cars in a location while some have six or seven. As demand increases over time, more cars are added to a location. The largest car sharing lot right now is at the California Pacific Medical Center at 45 Castro with seven cars. Assuming a regional program of 60 – 80 stations, each station will have about 12-16 cars per location.

Table 2 – Potential Station Car Stations

City/ unincorporated area	Site	Transit Operator
Pleasanton	Hacienda Business Park	
Fremont	Irvington	BART
Hayward	Downtown	BART
Castro Valley	At BART station	BART
San Leandro	Downtown	BART
Oakland	Fruitvale BART	BART
Oakland	Lake Merritt - East Shore	BART
Oakland	Eastmont TownCenter	AC Transit
Oakland	MacArthur Transit Village	BART
Oakland	Lake Merritt BART	BART
Oakland	Old Oakland/Swan's Market	BART / AC Transit
Oakland	Jack London Square	AC Transit / Alameda Ferry
Oakland	Rockridge (2nd location)	BART
Alameda	Marina Village	AC Transit
Emeryville	San Pablo Corridor	AC Transit
Berkeley	Solano/North Berkeley	BART
Berkeley	Ashby BART	BART
Walnut Creek	At BART station	BART
Pleasant Hill	At BART station	BART
Concord	At BART station	BART
Lafayette	At BART station	BART
San Rafael	Canal neighborhood	GG Transit
Marin City	Downtown	GG Transit
Larkspur Ferry Term.	Ferry Terminal	GG Transit
Napa	Downtown	Napa Vine
San Francisco	Glen Park BART	BART
San Francisco	Balboa Park BART	BART
San Francisco	Phelan Loop	SF Muni
San Francisco	Marina	SF Muni
San Francisco	Inner Sunset	SF Muni
San Francisco	Nob Hill	SF Muni
San Francisco	Cow Hollow	SF Muni
San Francisco	Outer Mission	SF Muni
San Francisco	4th and King	Caltrain/SF Muni
San Francisco	22nd Street Station	Caltrain/SF Muni
South San Francisco	South SF BART	BART
Millbrae	Millbrae Intermodal	BART/Caltrain
Daly City	Daly City BART	BART/SamTrans
San Mateo	Hillsdale/Bay Meadows	Caltrain/SamTrans
San Mateo	Downtown	Caltrain/SamTrans
Redwood City	Downtown	Caltrain/SamTrans
San Carlos	Downtown	Caltrain/SamTrans
East Palo Alto	Four Corners	SamTrans
San Jose	Paseo San Antonio	VTA
San Jose	Santana Row	VTA
San Jose	Willow Glen	VTA
San Jose	SJSU I	VTA
San Jose	SJSU II	VTA
Palo Alto	Downtown I	VTA/Caltrain
Palo Alto	Downtown II	VTA/Caltrain
Palo Alto	California Avenue Caltrain	Caltrain
Mountain View	The Crossings	VTA/Caltrain
Mountain View	Castro Street (near station)	VTA/Caltrain
Sunnyvale	Downtown	VTA
Santa Clara	Santa Clara Univ.	BART
Vallejo	Downtown	Vallejo Transit
Vallejo	Ferry Terminal	Vallejo Transit
Santa Rosa	Downtown	Santa Rosa Transit

Other Considerations

Size of the Program

By 2006, it is assumed the station car program will have 1,000 vehicles in operation throughout the region. This represents a ten-fold increase over the programs in existence today.[1]

Vehicle Technology

To provide the greatest benefit for air quality, station cars should use Zero or Super Ultra Low Emission Vehicles (ZEV and SULEV respectively). However, these technologies are still fairly new to the consumer market and are not in widespread use. Some of the initial station cars would probably need to be "hybrids" which are currently on the market (e.g. the Toyota Prius). Electric vehicles (such as Ford Think!) would require higher investments in station infrastructure for re charging. By using ZEV's it would be a way of helping automakers comply with CARB's ZEV mandate.

Availability of Parking

One of the more germane questions is, "Where will the vehicles go?" If FlexCar and City CarShare can serve as examples, there are many creative ways to park station car vehicles. In some cases, parking can be provided directly on site if the transit operator supports the use of parking spaces for station cars. The California Avenue Caltrain station, for example, has FlexCar vehicles parked in the station parking lot. In other cases, street parking can be utilized. At the Lake Merrit BART station in Oakland, City CarShare uses on street parking to store the vehicles in the Lake Merritt pod (City CarShare and the City of Oakland have an agreement to store vehicles on city streets). The decisions about parking are likely to be made on a case-by-case basis and negotiated between the car sharing organization, the transit operator, and the local city.

Program Costs

Standard or Hybrid Vehicle. Cost for infrastructure will vary depending on the type of vehicle technology being used. If standard or hybrid vehicles are used for the car sharing fleet, the main infrastructure requirement will be a parking space and a sign designating the space as a car sharing space. Assumed cost for each vehicle is $15,000 over a five-year lease period.

Electric Vehicle. If the regional station car program opts for electric vehicles to be a part of the fleet, quick charging stations will be required. Thus, an electrical hook up and the equipment needed for charging are required. Conductive charging would cost $2,000 per space and inductive charging would cost $3,000 per space for equipment[2]. Wiring and conduit is also needed to charge a vehicle. Total costs are estimated to range from $7,000 - $20,000 to outfit a parking space to recharge an electric vehicle. The main cost variables are the proximity of space to the power source, need to upgrade wiring, wiring

[1] City CarShare began over a year ago and now has over 1,700 members and a fleet of 80 cars. FlexCar began as CarLink II and has ??? members with a fleet of ?? cars.

[2] Conductive charging is similar to a wall plug in a house. Metal to metal contact and similar electrical exchange. Inductive charging uses a paddle, cased in plastic, and the charge works off a magnetic field. Both methods are safe for the user. Both charge over the same period of time.

installation, etc. Costs are highly dependent on the location of the parking space and infrastructure currently available.

Assumed cost for each vehicle is $15,000 --assuming a $9,000 rebate from the Air Resources Board (CARB) incentive program and a vehicle price of $24,000. These costs could be further reduced through partnerships with automakers

For the prototypical 1000 vehicle program, the costs are summarized below:

Table 3-Conceptual Program Cost

Regional Program Utilizing Standard Fleet:

Item	Number	Cost
Vehicles (@ $15,000 per car)	1,000	$15,000,000
Cost Per Parking Space	NA	$0.00
Program Administration (including car upkeep)		$5,000,000 per year

Regional Program Utilizing Electric Vehicles and Super Ultra Low Emission Vehicles

Item	Number	Cost
Vehicles (@ $24,000 per car)	1,060 – 1,100 (Additional vehicles per station to allow for vehicle recharge. Some stations may need more than one.)	$26,400,000
Cost Per Parking Space	$7,000 - $20,000	$7,420,000 - $22,000,000
Program Administration (including car upkeep)		$5,000,000 per year

TransLink®

To simplify matters for regional travelers, TransLink® can be used as the device to open the car door and to charge the transaction. Currently, City Car Share uses what they call a “key fob” which is a device that, when in close proximity, can be used to open the door of the reserved car. TransLink® can perform a similar function for the regional program. Should the region move forward, a universal fare medium should be utilized. Simplicity and user friendliness should govern the regional program. It is anticipated that MTC will work with regional car sharing organizations to develop an access method where TransLink® can be used.

Station Cars and Interoperability

There are at least two organizations in the state currently offering car-sharing services. Implementing a regional program requires a system allowing members of any organization to use available station cars. Rather than have multiple operators with different fares and fare policies, a regional program should be developed with one set of fares and policies for use by all eligible travelers in the region. How this will be accomplished must be discussed between any interested organization, MTC, and the affected transit operator.

Optimal Flexibility
A successful station car program will take advantage of new technologies that allow for one way rentals, GPS tracking of vehicles in the fleet, and smart parking management strategies that help store cars efficiently and make them easy to access for the user. New car technologies will allow for more cost effective use of the system. Without finding a way to allow for a more flexible model of car sharing, it is unlikely a station car program will compete well for the commuter market.

Station Cars and Self Sufficiency
For a station car program to work, it is likely public/private partnerships will always be needed. Like transit, subsidies may be needed over the long term to make this an attractive alternative to driving alone.

ZEV Mandate's Transportation Systems Credits – Possible Opportunities
Given the many synergies among clean fuel vehicles, car sharing, and station car programs, CARB proposed in 2001 to award additional ZEV program credits for zero and low emission cars introduced into shared-use vehicle systems. Beginning in 2003, the ZEV program requires large volume automakers in California to produce clean fuel vehicles for sale. While this date is currently in question due to disagreements between CARB and automakers, it is anticipated that the implementation of the ZEV program will proceed within the next few months.

Clean cars covered by the ZEV mandate range from pure electric and fuel cell vehicles to hybrid and super ultra-low emission vehicles with no evaporative emissions. CARB's linkage of technology and demand-management strategies is based on studies suggesting that significant environmental benefits can arise from shared-use vehicle systems. This is particularly important when low-polluting (e.g., battery electric, compressed hydrogen, and hybrid electric) vehicles are introduced into transportation systems (e.g., carsharing systems linked to transit). To qualify for transportation system credits, the placed ZEV program cars must have multiple uses per day, be equipped with telematics which optimize daily vehicle usage, and be located adjacent to rail transit hubs. The incentives for automakers to participate in transportation system programs are significant. Each placed vehicle can earn up to four times the number of ZEV credits compared to a ZEV car placed in regular service by single use individuals.

B. Transit Access by Bicycle

Bikestation Palo Alto at California Ave. Caltrain Station

Using a bicycle in conjunction with a transit trip has become a popular form of commuting in the Bay Area. All of the region's transit operators are now equipping their buses with front mounted bike racks. All of the regions rail operators, with the exception of Muni Metro, allow bicycles on board their vehicles – with some exceptions during rush hour. Bicycles help overcome some of the limitations of fixed route transit service by allowing the traveler to use their bicycle to get from home to the station or from a station to work.

Safe Routes to Transit

Bicycle access to transit received more attention recently in connection with proposed state legislation that would have identified a "Safe Routes to Transit" program. While the legislation did not pass, it has galvanized the thinking about use of bikes to transit stations. Only a few stations have direct bicycle access via bicycle lanes or bike trails with direct connections from those facilities to the station entrances. Topography and weather also play a role in determining whether or not bicycling is an attractive mode to reach a transit station. During the development of MTC's 2001 Regional Bicycle Plan, better access to the transit system was identified as a top priority. For better bicycle access, bike lanes, signage directing cyclists to transit stations from the surrounding community, better access within the station property, and higher quality bicycle parking are required. Any expansion of bike stations or bicycle parking at specific transit stations should be done in conjunction with efforts outside the stations to allow people to directly and safely reach transit stations using a bicycle.

Bicycle Parking

While bicycles can be brought on board BART, Caltrain, and VTA, there are some capacity problems, particularly during the peak period. BART and Caltrain both experience heavy demand during the rush hour, making on board storage of bicycles difficult. Trains are generally full and bringing a bike on board a crowded train is problematic for the cyclist and inconvenient for other patrons. VTA does not have such a crowding problem and the bicyclists can generally bring their bikes on board most trains.

Station storage options may offer a better approach – particularly during commute hours. By providing bicycle parking at stations, transit patrons can use their bicycles to reach the station and then ride transit to their desired location. By providing facilities to adequately store bicycles, more people may be encouraged to ride to the transit system as they can be assured their bicycle will be safe while they are away for the day.

Secure facilities are essential as theft is one of many disincentives for riding bikes to a transit station. For example, over the past three (3) year's BART patrons lost 449 bicycles or bike parts in 1999, 421 in 2000, and 453 in 2001 due to theft. Bicycle racks do not offer the same level of security as a bike locker or a bike station approach. Parking a bicycle at a rack on the street exposes the bicycle to possible theft or vandalism.

Bicycle Lockers

Bicycle lockers are a storage device that secures a bicycle in a box rather than securing a bike to a pole or a rack. Lockers protect the bicycle from weather, make it difficult to remove parts from the bicycle or damage it. They also offer a place to store clothing or gear used by the cyclists to reach the station. Lockers are seen as a higher quality and more secure bicycle-parking feature.

Lockers are offered at many locations along the region's rail network, but there is often a waiting list to obtain one. Further complicating matters, a traveler can not simply ride to a station and use a locker in the same way a driver can drive to a station and park for free. A bike rider must reserve a locker in advance and if all lockers are reserved, a choice must often be made between leaving a bike in an unsecured location and not riding at all.

The Bicycle Pavilion

Bicycle Pavilions are an array of lockers clustered around a transit station or a secure area where pre-screened users can enter and leave using something like a TransLink® smart card or a device similar to a key fob utilized by City CarShare. These storage areas are intended for stations with a high demand for bicycle parking allowing cyclists to store their bicycles without worry or vandalism. Pavilions can also have design features and other elements to help integrate the parking facility into the transit station and to draw attention to them.

The main issue with bicycle pavilions is making the bike locker available to the user. Current reservation systems are cumbersome for transit operators and users. Lockers can only be used by one person. The user is given a key and the locker is theirs – every day, even if they are not using it. A better approach would be to use a device such as a key fob or a Translink card to access the locker for the day.

Current and Possible Future Parking Expansion Stations

After reviewing transit operator and county bike plans, the following stations represent logical locations for investing in a more aggressive bike storage/access strategy.

- 12th Street
- 16th Street
- 19th Street
- 24th Street
- Civic Center
- Coliseum/Oakland Airport
- Dublin/Pleasanton
- Fremont
- Fruitvale
- Lafayette
- Lake Merrit
- MacArthur
- Montgomery
- Orinda
- Powell
- Richmond
- San Leandro
- West Oakland

<u>Staffed Bicycle Parking</u>

A staffed bicycle parking facility is attended bike parking at a transit center. It offers a bicyclist a secure place to store, repair or rent a bicycle in conjunction with taking a transit trip. These are most likely to be used at stations where bicycle demand is high or where there is limited space for a locker or bicycle pavilion approach. The Berkeley Bike Cage takes up very little room in the Berkeley BART station, but can store up to 100 bicycles. The same number of bikes stored in bicycle lockers would occupy considerably more space within the station.

At the Bikestation Palo Alto, users are able to take Caltrain to Palo Alto and then use their stored bicycle to travel to work or to Stanford. Bicycles are parked by staff and checked out by the user. Residents of Palo Alto may ride their bicycle to the Caltrain station and store their bicycle there while they travel to other destinations on the Caltrain corridor. Other amenities such as bike rentals, equipment sales, refreshments, maps, and transit schedules are available in addition to a bicycle mechanic to repair bicycles at the facility.

The Berkeley Bikestation is inside the Berkeley BART station on the concourse level. On average, about 80 – 90 bicycles are parked each day. The following was learned after a recent survey conducted by BART:

Most trips were from home to either work or school.

- 72% of users parked their bikes before riding BART, 18% parked their bikes after riding BART and 7% didn't ride BART at all
- 2/3 of customers used the Bikestation at least three days a week
- 80% had taken BART for similar trips before the Bikestation, 7% had driven, and 3% bicycled the whole way
- 20% might consider traveling by other means if the Bikestation were not available.

Relevant Bikestation Experience
There are three Bikestations (a registered trademark) operating in the state. Bikestations are staffed bicycle parking facilities that are part of a network of Bikestations. These facilities are members of the Bikestation Coalition utilize the same operating system for parking bicycles and providing other services to commuters. Two are in the San Francisco Bay Area and on is in Long Beach. Long Beach was the first one in operation opening in 1996. Long Beach and Palo Alto have similar levels of use and Berkeley is somewhat higher. The average number of users on a typical weekday for each of the Bikestations is reported below:

Long Beach
- -Monthly parking: 1025
- -Weekday average: 46

Palo Alto
- -Monthly parking: 1063
- -Weekday Average: 48

Berkeley
- -Monthly parking: 1797
- -Weekday average: 79

Bikestations are most appropriate for transit stations that have demand for over 100 bicycle parking spaces on a given day. They are also better suited for stations with bicycle demand throughout the day. Again, using transit operator station access plans, and county wide bicycle plans, the following stations would represent good candidates for establishing bike stations:

Table 4 – Potential Bike Stations

City/Unincorporated Areas	Site	Transit Operator
Oakland	Fruitvale BART Station	BART
	Downtown Oakland	BART
Pleasant Hill	BART Station	BART
Larkspur	Larkspur Ferry Terminal	GG Transit
Sausalito	Sausalito Ferry Terminal	GG Transit
Downtown San Jose	Diridon Station	VTA/BART/Caltrain
Santa Clara Intermodal	BART Station	BART/Caltrain

Other Considerations

Space Requirements
For stations where higher quality bike parking is desired, the space requirements are for bike lockers or pavilions. Their spatial dimensions are 21 square feet for a locker that typically stands about four feet high. The number of lockers required will determine the amount of space needed. For the purposes of this analysis, we are assuming 1,200 new lockers are needed.

A bicycle parking facility is typically located in close proximity to transit if not within the transit station itself. Facilities parking bicycles and providing other amenities such as bicycle rental, repair and some retail sales typically require from 1000 to 1,500 square feet of space or more, depending on the design. About 100 – 200 bikes can be stored in that space depending on the storage approach. More bikes can be stored if there is a safe method for hanging bicycles from the roof. To locate a station within a transit station itself will require the consent of the transit operator. If the station is adjacent to the transit station, there may be lease costs or land acquisition costs. These issues are likely to be determined on a case-by-case basis.

<u>Who operates a staffed bicycle parking facility?</u>
For the purposes of this analysis, it is assumed that a retail bicycle shop, a local bicycle advocacy coalition, or the Bikestation Coalition could operate new bike stations in this region. Such facilities are usually staffed by at least one or two people (two people staff Palo Alto Bikestation while the Berkeley Bikestation has one staff member).

<u>Decentralized and self-accessing lockers at key transit nodes</u>
For bike lockers and pavilions, it is important that lockers be available on a first come, first served basis. The lockers will need to be self-accessing, in a similar fashion to how car sharing member's access shared vehicles. Using some type of device, preferably TransLink®, the user would arrive at the station, wave their card over a reader, and store their bicycle in the bike locker. There should be no charge for this service unless the transit agency already charges for parking.

<u>Costs</u>
The proposed staffed bicycle parking facility for the Embarcadero BART station is estimated to cost $300,000 to construct inside the Embarcadero Station. Cost may vary depending on where the station is built and the materials used. Construction of a bike station can be of minimal cost as is the case in Bikestation Berkeley where there is a "Bike Cage." The Bike Cage in the Berkeley BART station is merely a chain link fence that is attended during the day. Assumed costs for constructing a bike station at one of the region's major transit stations is $300,000.

For unmanned bike parking or bike pavilions, the main costs are for providing the locker. A bike locker can range in cost from $800 - $2,000, depending on the type of locker selected. For the purposes of this analysis, a locker price of $1,000 is assumed.

<u>Costs of a Regional Bikestation and bicycle parking expansion program:</u>
Estimated cost for an expanded regional bike program (not including access improvements outside stations) is shown in the table below.

Table 5 - Conceptual Costs for Improved Bicycle Access to Transit

Item	Capital	Operating
Fully staffed Bikestation	7 @1,500 sq. ft. each = $2,100,000	$80,000 - $100,000 per year
Bike Substations	60 Bicycle Pavilions (average 20 lockers per station @ $1,000 ea) = 1,200,000	
Total Costs of Regional Program:	$3,900,000	$80,000 - $100,000 per year

C. Regional Shuttle System and Transit Access

Bay Area shuttle services provide important links between transit hubs and their surrounding communities. There are more than 170 different shuttles currently in use throughout the Bay Area. Shuttle services are designed to complement and supplement fixed-route buses by offering fast, limited-stop service direct to specifically targeted destinations. Shuttle services can eliminate the need to use a personal automobile by providing convenient, inexpensive and nearly seamless rail/bus transit trips.

- There are more than 170 different shuttles currently in use throughout the Bay Area.
- Shuttles are operated and funded by employers, transit operators, BAAQMD, cities, universities, hospitals, congestion management agencies and business associations.
- Shuttles typically provide service from BART, Caltrain, ACE or light rail to major employers, schools, medical facilities and commercial districts.
- While most shuttles operate during peak commute hours, some also provide midday, evening and weekend services to assist off-peak workers, students, shoppers, seniors, etc.
- Shuttle services can eliminate auto trips by providing convenient and inexpensive transit connections.

Most shuttles combine public and private funding from multiple interests. As a result, shuttle service often involves multi-party agreements among transit operators, businesses, cities and others. Shuttles are typically operated on a contract basis by private shuttle companies, which provide vehicles and drivers. Rates for these services range between $35 and $75 per hour of service. In a few cases, shuttle vehicles are owned by an employer or other entity and are operated with in-house staffing, insurance, etc. Hourly costs for these shuttles can be less than for contracted services.

The majority of the shuttles operating in the Bay Area use diesel-powered vehicles. This includes full-sized coaches, mid-size (30-32 passenger) buses and 15-25 passenger “cutaway” vehicles. There are an estimated 20 clean fuel shuttles in the Bay Area using CNG, electricity, and propane or hybrid-fuel engines. Since shuttles drive tens of thousands of miles each year and typically return to a “home base” at the end of a shift, they may be excellent candidates for alternative fuels. However, these clean fuel vehicles add an additional cost to shuttle operators.

Current Use

Shuttle services vary widely from region to region within the Bay Area. For example, the Caltrain Corridor is home to an extensive system of more than 50 shuttles operated by the Caltrain JPB, Samtrans, the Peninsula Traffic Congestion Relief Alliance, major employers and cities. In Santa Clara County, VTA shuttles carry 42% of ACE train riders to their destinations. Emeryville's Emery-Go-Round now carries more than 600,000 workers, residents and shoppers annually on a nearly 100% privately funded bus system. Successful shuttle programs also serve high volume destinations such as Stanford, UC Berkeley, or Sun Microsystems. In most parts of the Bay Area, however, shuttles have not been an integral part of the transportation planning and funding process and are significantly under-exploited.

The list below shows some of the region's more successful shuttle programs. These shuttle programs represent a variety of service-types and show a range of ridership that can be achieved.

Table 6 - Model Shuttle Programs

Shuttle Program	Routes	Riders/day	Best Practices
Caltrain/Samtrans /Alliance	52	6,000	• Partnership approach—Caltrain, Samtrans, Peninsula Alliance, BAAQMD, cities, C/CAG, Transportation Authority, employers—yielding excellent results • Caltrain new shuttle costs offset by increased train revenues • Alliance providing new model for shuttle development and management
Emery-Go-Round	7	2,500	• 100% private funding (business assessment district) • Serves employees, shoppers and residents 7 days/week
VTA/ACE	18	3,000	• Seamless ACE/shuttle system planned early in ACE process • DASH Caltrain/light rail downtown shuttle carries 1,000 riders/day
UC Berkeley	6	3,000	• Holds costs down thru innovative agreement with AC Transit for buses, maintenance and driver training • 7 days/week including late night service • 100% UC funding (parking fines)
Stanford	12	3,500	• 20 hour/7 day system • Serves campus, medical center, shopping center • 100% Stanford funding (parking fees)

Table 6 - Model Shuttle Programs (Cont'd)

Sun Microsystems	8	450	• 100% Sun funding • Serves Caltrain, BART, ACE and inter-campus travelers
Silicon Valley Power (City of Santa Clara	2	100	• Uses electric-propane hybrid buses from ACE and Caltrain to employers • Funded through public benefits assessments on electric bills
Broadway (Oakland)	1	1,600	• Downtown mid-day serves shoppers, lunchers, etc. • Partnership: Oakland, Port, Caltrans

Opportunities and Constraints

As the Bay Area's expands and improves BART, Caltrain, Amtrak Capitol Corridor and ACE trains over the next decade, we will need more shuttles to get passengers that critical distance to their final destinations. In addition, shuttles could play a key access role in the expansion of water transport and express buses. Perhaps most importantly, much of the costs of this shuttle expansion can be offset by (a) the increase in rail/ferry/express bus revenue generated by attracting new shuttle riders and (b) private sector funding.

A review of Bay Area shuttle programs has highlighted some of the key barriers that must be addressed if we are to expand the Bay Area shuttle system.

Regional:

- <u>No consistent regional shuttle program</u>. Some areas have aggressively organized shuttles while other areas have very few. Employers in some areas pay 100% of shuttle costs, while in other areas only 25% is required, and in still others employers pay 0%. There is no clear lead-party for new shuttle development.

- <u>Shuttles and regional rail</u>. Overall, shuttles are not yet seen as an integral part of the regional rail network. Regional rail plans detail routes, stations, capital costs, etc., not how riders will get to and from stations. A few agencies' planning processes are now considering shuttles.

- <u>Regional funding</u>. BAAQMD's TFCA funding is the only regional funding available for shuttles.

Transit Agencies:

- <u>Service priorities.</u> Shuttles are not a high priority and shuttle programs are not institutionalized at most agencies. (Caltrain/Samtrans is an excellent exception.)

- Competition Perception. Some transit agencies may see shuttles as competition for fixed-route services. (Caltrain, Samtrans, VTA and others have proven that shuttles and fixed-route can complement each other.)

- Funding. Current lack of transit agency funding restricts shuttle development by public agencies.

- Work-end. Most shuttles are at the work-end; very little experimentation with home-end shuttles for rail stations.

Employers and Cities:

- Resources. Employers scared away from joint transit-employer shuttles by time-consuming lead employer role required by some transit agencies (liability, management time, financial issues, etc.)

- Costs. Private shuttle costs ($80K-100K per year plus administration) are too much for most employers. (Caltrain/Samtrans 25% employer share is attractive to employers.)

- Regulations. Regional and local TDM regulations that encouraged employer shuttle development were repealed by state law in the early 1990's.

Levels of Shuttle Service

Additional shuttle service could both expand existing shuttle services and create new shuttle routes. These services would fall into the following categories based on the level of service provided:

Table 7 - Levels of Shuttle Service

Level of Service	Typical Location	Days of the Week	Hours of Operation	Lines	Peak Hour Headway	Off Peak Headway	Daily Ridership
Tier I	Major Destinations	Seven days per week	6 am to 10 pm	5-10	5-15	20-30	2000-5000[1]
Tier II	Downtown	Monday to Friday	7 am to 7 pm	1-3	5-15	10-20	1000-2000[2]
Tier III	Employer	Monday to Friday	Peak Periods (mid-day optional)	1-2	20-45 Meet Transit	--	100-200[3]

1. Based on Stanford Marguerite UC Berkeley
2. Based on San Jose DASH and Broadway Shuttle
3. Based on Caltrain, Broadway Shuttle and ACE shuttles

Conceptual Cost Estimates

The information below provides operating costs for shuttle operations based on contracted rates around the Bay Area. These estimates do not include the time it takes to plan, develop, and locate funding for a shuttle route. These costs are based on contracting rates with private operators to supply vehicles, drivers, and maintenance. (Operating costs can be somewhat less for programs that own their own vehicles, but these programs will have capital costs.)

Based on rates provided by Bay Area shuttle operators, the costs for each type of service were estimated for both a "low" and a "high" cost. For Tier I, the costs range from $35-$50 per hour. For Tier II and Tier III, the costs range from $50-$75 per hour. These results are found in the following table.

Table 8 - Conceptual Shuttle Operating Costs

Type of Service	Routes	Vehicles	Hours/ day	Days/ Week	Hours/ Year	Total Annual Cost Range	
						Low	High
Tier I	2	10	16	7	58,240	$ 2,038,000	$ 2,912,000
Tier II	1	4	12	5	12,480	$ 624,000	$ 936,000
Tier III	1	1	7	5	1820	$ 91,000	$ 136,500

Cost Estimate

Assume BART, Caltrain, and VTA/ACE shuttle services are expanded by roughly 10%, adding 12 shuttle routes. The cost of deploying these services would consist of:

- Four Tier I shuttles, costing between $8,152,000 and $11,648,000
- Four Tier II shuttles, costing between $2,496,000 and $3,744,000
- Four Tier III shuttles, costing between $364,000 and $546,000

Total cost would be between $11,012,000 and $15,938,000 for fully contracted service. This service would carry 12,000 and 28,000 passengers annually.

Emission Benefits for All Transit Access Components

To approximate emission reductions from the three types of transit stations access improvements—station cars, bike access, and shuttles—a series of assumptions was necessary to develop order of magnitude emission reduction estimates. These assumptions are explained in detail in Appendix C. The emission reductions are a function of the size of the access improvement program, and the calculations are based on a modest program size for each:

Station Cars: Expand program to about 10 times current level, or 1,000 cars
Bikes: Increase number of Caltrain and BART riders accessing these systems by bike by 1,800 riders a day
Shuttle*s:* Increase number of shuttle routes operated to VTA/ACE, BART and Caltrain by 10% or about 12 routes.

Table 8 summarizes the emission calculation results.

Table 9 - Emission Benefits from Transit Access Improvements
(Tons per Day)

Access Improvement	VOC Reductions (tpd)	NOx Reductions (tpd)
Station Cars	0.009	0.018
Bike Stations	0.014	0.012
Shuttles	0.10	0.12

D. Other Ideas

Developing technologies may present other opportunities with respect to station access. One new parking management technology would be to provide real time space availability for transit parking facilities. If this information is provided at some point in the passenger trip (either by in vehicle devices or roadway message signs) potential transit users may determine that it is more convenient to use the transit system than continue on the road in a congested corridor or one that may have just experienced a major traffic incident.

Car technologies are also rapidly evolving, particularly in terms of fuel cell applications. The station car concept may be a good platform to test some of these technologies.

Appendix A

Particulate Matter (PM) Emission Reduction Calculations

1**. 202** vehicles scheduled for repower or retrofit at a cost of $16,828,918

2. Without any upgrade work done, these buses would emit **10.83** tons per year of PM would be emitted

3. **202** vehicles upgraded with repowers and retrofits would emit **4.79** tons per year of PM

4. Alternatively if the $16,828,918 were used exclusively to purchase **46** new vehicles instead, PM emission reductions would only be **1.23** tons per year

5. <u>Net Benefit from Repowers/Retrofits</u>: The net emission reduction benefit is equal to "3" minus "4" or **3.56** tons per year of additional PM reductions from MTC's funding policies which provide for repowers/retrofits as an alternative to replacement of the entire bus

Appendix B

Technical Description of Particulate Filters

In general, a diesel particulate filter (DPF) consists of a porous substrate that permits gases in the exhaust to pass through but traps the PM. DPFs are very efficient in reducing PM emissions; they can typically achieve PM reductions in excess of 90 percent. Most DPFs employ some means to periodically regenerate the filter (i.e., burn off the accumulated PM). These can be divided into two types of systems, passive and active.

Unlike passive DPFs, active DPFs use a source of energy beyond the heat in the exhaust stream itself to help regeneration. Active DPF systems can be regenerated electrically, with fuel burners, with microwaves, or with the aid of additional fuel injection to increase exhaust gas temperature. Some active DPFs induce regeneration automatically on-board the vehicle or equipment when a specified backpressure is reached. Others simply indicate to the operator when regeneration is needed, and require the operator to initiate the regeneration process. Some active systems collect and store diesel PM over the course of a full day or shift and are regenerated at the end of the day or shift with the vehicle or equipment shut off. A number of the smaller filters are removed and regenerated externally at a "regeneration station."

Because they have control over their regeneration and are not dependent on the heat carried in the exhaust, active DPFs have a much broader range of application and a much lower probability of getting plugged than passive DPFs. One result of this is that emission control groups for active systems are most likely larger than those for passive filters, depending on the particular system. While actively regenerated traps do not generally increase NO_2 emissions as passive DPFs may (unless they include catalysts), special attention needs to be given to active traps during regeneration. Spikes in emissions have been observed to occur during regeneration, prompting European researchers involved with the VERT project to require emission measurements over the regeneration period. ARB's verification procedure incorporates the same requirement.

Appendix C
FSM 5 Emission Reduction Calculations

<u>Assumptions-Station Access cars</u>

- Each car generates “new” transit trips, i.e., trips that were formally made by car (this would be the maximum program benefit):
- For work trips, a scenario would be:
    1. A person uses their own car or transit to get to BART/Caltrain in the morning
    2. They pick up a car at the destination end of the trip and use it to get to work; they keep the car all day (possibly using it for errands in the mid-day) and return it to BART/Caltrain in the evening.

- For non work or work-related trips:
    1. A person uses their own car or transit to get to transit
    2. They pick up a car at the destination end of the trip and return it when done.

- 50% SULEV and 50 ZEV vehicle type distribution for Station Access car fleet
- 90% LDVs and 10 SUVs vehicle type distribution for replaced conventional vehicle types
- 100% cold start modes for 800 Station Access cars
- 5 mile trip length for Station Access car travel from transit station to workplace
- base case conventional vehicle emission factors generated from EMFAC 2001, v2.08 for a 2006 Bay Area inventory
- 16 mile conventional vehicle work trip length replaced by “new” transit trip
- each of the 200 Station Access cars are used 5 times a day
- 1 out of the 5 daily Station Access car uses is a assigned a cold start emission factor, the other 4 daily starts are assigned an average start emission factor
- Station Access cars are replacing one trip chaining event for each person’s work-to-home journey (i.e., to run an errand on the way home from work)
- One-way 5 mile trip length for Station Access car non work travel from transit station to errand location
- Average 30 minutes vehicle rest time while errand is being conducted

<u>Assumptions-Bikes stations, etc.</u>

- Assume bike trips are for access to BART/Caltrain
- Assume the bike trip replaces a car access trip to transit (rather than attracts a new trip to transit)
- Use the figures in the report for BART and Caltrain bike access trips
- The Caltrain increase in bike access is 3,000trips (10% mode share of access trips)-2,400 trips (current mode access share of 8.3%)=600
- BART is adding 3,100-1,900 (current)=1,200
- 5 mile trip length between home and transit station

- 90% LDVs and 10 SUVs vehicle type distribution for replaced conventional vehicle types
- base case conventional vehicle emission factors generated from EMFAC 2001, v2.08 for a 2006 Bay Area inventory

<u>Assumptions-Shuttles</u>

- Assume 10% increase in shuttle routes for VTA/ACE, BART, and Caltrain=12 new routes
- Assume an average of 1,000 daily riders x 6 routes=6,000 new daily users
- Assume they all were all work trips made by car that are now made by transit
- 10 mile work trip length between home and workplace
- 90% LDVs and 10 SUVs vehicle type distribution for replaced conventional vehicle types
- base case conventional vehicle emission factors generated from EMFAC 2001, v2.08 for a 2006 Bay Area inventory

Possible Episodic Controls for Transportation

Several very preliminary ideas are presented below for possible episodic controls to begin a discussion of this topic. Episodic controls would be employed on the 6 to 7 Spare the Air days to provide significant reductions in motor vehicle emissions and thereby avoid exceedances of the federal ozone standard. They would be more stringent in terms of their effect on the traveling public, but may be acceptable given the short time during which the measures would be in effect. The measures would have some enforceable aspects in order to claim SIP credits. The preliminary ideas include the following:

- Reducing high speed travel on freeways
- Limiting use of 1981 or older cars
- Mandatory employee telecommuting option
- Free transit

1. Reducing High Speed Travel on Freeways

Cars and trucks generate proportionately higher emissions when traveling at high speeds on freeways. High speeds are defined as speeds above the posted speed limit, which is 65 miles per hour for cars and 55 mph for trucks. The detailed evaluation of this measure is presented under Further Study Measure 3 for the 2001 Ozone Attainment Plan. The episodic version of the measure would be to expand enforcement of freeway speed limits on the 6-7 Spare the Air days. Since speed is also one of the most prevalent factors in vehicle accidents, this strategy would have a positive impact on highway safety as well.

Emission Benefits. Working with the California Air Resources Board (CARB), calculations were made of the potential emission reductions for cars and trucks. The analysis used actual Caltrans data from speed surveys for selected Bay Area freeways and CARB's latest motor vehicle emission factors for the Bay Area. Because Caltrans speed data represents a sample of Bay Area freeways, the data was statistically expanded to reflect travel on all Bay Area freeways. CARB provided two different sets of speed correction factors, based on the latest EMFAC emissions model, to bracket likely emissions for vehicles at speeds over 65 mph. The high-speed vehicle emission rates were then applied to the amount of freeway travel occurring in the different freeway speed ranges.

For passenger cars, limiting freeway travel on all Bay Area freeways to 65 miles per hour, the amount of emission reductions would be as follows:

- VOC emissions would be reduced by **1** to **2.8** tons per day if applied to the entire Bay Area
- NOx emissions would be reduced by **0.9** to **1.9** tons per day if applied to the entire Bay Area

For big rig trucks, limiting speeds to 55 mph would reduce NOx emissions by over **20** tons per day (the exact number depends on the distribution of truck speeds above 55 mph, which cannot be determined from the Caltrans speed survey data).

Because the above estimates apply to the entire region, implementation could be unwieldy. Two more focused strategies were also considered for enforcing speed limits. These strategies would have somewhat lower emission benefits.

- Enforcement of posted speed limits (which vary between 40 and 65 mph) during the mornings (5 a.m. to 1 p.m.) on all freeways in the urban core. Assuming a 75% enforcement effectiveness, VOC reductions would be 0.4 to 0.9 tons per day; NOx would be 0.5 to 0.8 tons per day).
- Enforcement of speed limits for trucks on the major truck routes only. NOx emission reductions would by 4-5 tons per day.

Other Considerations

As discussed in the main discussion of FSM 3, the results of this analysis are somewhat inconclusive given the uncertainty about the high speed emission factors themselves (linear vs. exponential), the true VOC/NOx ratios and their effect on the expeditious attainment of the ozone standard, and the ability to claim SIP credits if the higher speed emissions are not recognized initially in the motor vehicle emission inventory. If some of these issues can be clarified, and alternative approach that did not involve enforcement would be to include messages about the positive impact of observing the speed limit in the public Spare the Air announcements.

For trucks the potential reductions in NOx are so large that they may be counter productive, unless limiting truck speeds is coupled with an equally or more potent VOC reduction strategy.

Authority: CHP has the authority to enforce the posted speed limits. This strategy would require the CHP to deploy more officers for speed enforcement on the 6-7 Spare the Air days.

Cost: The CHP would be reimbursed through a contract for their additional enforcement costs, including CHP officers and wear and tear on their vehicles. As an upper bound on the cost of such a program, we assumed 50 officers would be required for extra enforcement and these officers would work overtime for 4 hours to cover the morning period. The cost, including vehicle costs, would be about $15,000 per day, or about $90-$100,000 per year assuming six Spare the Air days. The way the program is implemented would depend heavily on CHP input, if this strategy is pursued.

2. <u>Limiting Use of 1981 or Older Vehicles</u>

Older vehicles have limited emission controls and create a disproportionately high amount of pollution. While normal fleet turnover is making the Bay Area vehicle fleet progressively cleaner, some high emitting vehicles remain in the fleet for a number of years. Using CARB's latest EMFAC emission factors for the Bay Area, which includes information on vehicles by age, it is possible to isolate the emission contribution of 1981 and older passenger cars and light duty trucks. These vehicles were found to constitute 8% of the Bay Area vehicle fleet while producing 34% of the VOC emissions and 18% of the NOx emissions for these vehicle categories. The episodic measure would seek to develop ways to reduce the number of older vehicles operated on Spare the Air Days. This approach would be more cost effective than attempting to scrap all these vehicles, which number about 350,000 (Under the Air District's current scrappage program where vehicle owners are paid $500 per vehicle, the cost of retiring this many vehicles would be about $175 million.).

People that own older vehicles would be asked to not drive on a Spare the Air day. This would mean either using a newer vehicle, if the household has access to such a vehicle, making a trip using another mode, or postponing a discretionary trip to another day. If free transit is part of an episodic program, people may have the ability to use transit for their trip at no cost (see below).

Emission Benefits. Limiting emissions from older vehicles on Spare the Air days has two significant advantages. First the tonnages are significant; therefore the source category is large. Secondly, limiting their use would reduce VOCs more than NOx, which as explained above is helpful in providing expeditious attainment. Using CARB's emission models, the following emissions are being produced by 1981 or older vehicles in the Bay Area:

- VOCs emissions: **56.7** tons per day, compared to an inventory of 214 tons per day for all on motor vehicles
- NOx emissions: **29.1** tons per day, compared to an inventory of 331 tons per day for all on road motor vehicles

While it is unlikely that any program would limit the use of all 1981 or older vehicles, a program that involves even a small portion of the 350,000 vehicles would have significant benefits. For example, if only 10% of the car owners participated, there would theoretically still be over 5 tons per day of VOC reductions.

Possible Approach. After an initial survey of owners of older vehicles, the program would be designed around one or two strategies, either a voluntary program assuming enough people would agree to non-operation of their vehicle, or an incentive program to enroll sufficient numbers of people to achieve meaningful emission reductions. Among other things, the survey would also attempt to determine whether low-income people would be adversely affected by a program focusing on older vehicles. Information gathered could be helpful in addressing any of these concerns. There could be a trial voluntary phase, followed by a more aggressive program that includes incentives. Experience with the Air District's smoking vehicle program indicates that some motorists are quite willing to undertake the repairs, suggesting some people would voluntarily agree not to drive, while others are upset with being reported and see the program as governmental intrusion into their lives.

To enlist greater participation from the owners on the fence, an incentive program could be considered. Moving to an incentive program would increase costs and would probably require a reporting and/or monitoring element to verify that vehicle owners earned the incentives by not operating their cars when informed of the Spare the Air Day. While there are technological means to determine whether a vehicle's engine is started or the car physically moves, this approach could lower the cost effectiveness of the program compared to a self reporting program that works on the honor system.

Authority. To claim emission (SIP) credits, the strategy would need to be enforceable. This aspect could prove problematic in that it is not the intent of such a measure to actually ban cars from use. However, if there is a way to accurately monitor the results through the reporting process, it may be possible to develop a record of success that could then be submitted as evidence that emission reductions are being obtained.

Cost. The main cost for a voluntary program would be the initial survey, and administrative staff to make participating vehicle owners aware of Spare the Air days.

-Initial survey: $50,000
-Administration: around $80,000 per year

Moving to an incentive program would involve higher administration costs to perform the monitoring of vehicle use (even if self reported by the owner) and the cost of the incentives themselves. There may be further costs involved with the use of technology to verify the vehicle was not used on Spare the Air days.

-Basic incentive package: $1.2 million, which assumes a 10% participation rate and the cost of free transit passes (only one of many possible incentives) to make trips in lieu of using the car that is not being operated.

3. <u>Employee Telecommuting</u>

Current state law (SB 437, Lewis, Health & Safety Code Section 40719.9) prevents any public agency from requiring employers to implement trip reduction programs. The telecommuting proposal would make an exception to this general prohibition by allowing certain individuals within companies to telecommute on Spare the Air days. New legislation would require large employers (100+ employees) to identify the workers or classes of workers that would be eligible for telecommuting, notify the employees of Spare the Air days, and allow the employee to work at home on that day, if the employee so chooses. This strategy would involve the business community in the air quality solution, and since the number of Spare the Air days is small, probably would not have large-scale impacts on business operations in the Bay Area. Around 2000 large Bay Area employers representing over a million employees are already enrolled in the Air District's Spare the Air network, indicating many businesses already believe that it is important to address commute travel patterns on these days.

Emission Benefits. Anecdotal evidence suggests there are probably a large number of workers who could do their jobs at home, at least on an intermittent basis. The most important air quality benefit would be gained by reducing the number of people driving to work in the morning. These early morning emissions accumulate over time and contribute to exceedances later in the day as emissions build up in the eastern parts of the region and temperatures increase. The air quality benefits would depend on several factors, including:

- some of the potential telecommuters may already use alternative modes of transportation modes to work
- some workers who stay at home may end up doing some driving during the day (however, some of these people may have used their cars at work anyway to conduct mid day errands).

Authority. New legislation would be needed to require employers provide the telecommuting option on Spare the Air days for eligible employees. Dissemination of these new requirements could be performed by CARB. While new legislation may not create a clear enforcement mechanism, many employees may pursue the telecommuting flexibility with their employer, making it somewhat self enacting.

Cost: There would be minimal public cost, except perhaps some informational material and initial notification to employers if legislation passes. There may be costs to CARB for follow up with employers. There may also be undefined productivity costs to employers.

4. <u>Free Transit on Spare the Air Days</u>

Another concept that has been tried elsewhere is to make transit free on Spare the Air days. While this strategy has been implemented in other areas with mixed results (see attached table), the chances of success are arguably higher in the Bay Area with an extensive transit system and awareness on the public's part that using transit could translate into less air pollution. The cost of the program would essentially be the daily revenue that passengers currently contribute out of their pocket in fares. An option to providing free transit throughout the entire system would be to provide free transfers between systems.

Emission Benefits. Emission credits may be difficult to claim if it is not possible to distinguish between the riders who use transit who would have otherwise driven. Some of the past and current programs have reported higher ridership on these days, but the transit operators also believe that many of the additional riders are normal transit users who took advantage of the free fare. Thus, it is difficult to provide a reliable estimate of the likely emission benefits. The benefits might be quantified through rider surveys if the program is implemented. Assuming that there is an actual ridership increase of 15% on Spare the

Air days, there would be about 0.7 tons per day less of VOC and about 1 ton per day less of NOx.

Authority. MTC has the authority to allocate CMAQ funds to transit operators for this purpose. CMAQ funds could be taken "off the top" by MTC in the next federal funding cycle. These funds would only be available for a 3-year period, after which they would need to be replaced with a new source if the program was to continue.

Cost. The cost per day would be approximately $1.5 million, or $9 to $10.5 million per year for the existing transit riders, depending on whether there are 6 or 7 Spare the Air days. Subsidizing only the transfers between systems could cost significantly less and still serve as a marketing and public awareness tool. Some have suggested raising bridge tolls on Spare the Air days and funding Transbay transit service with the additional toll revenues.

Programs that Offer Free and Reduced Fare Transit on Ozone Alert Days

City, State	Transit Operator	Years of Operation	Program Description	Ridership Increase	Comments
Vancouver	C-Tran	1995 to Present	Free rides on orange and red days	15 - 44%	In 1997, increases were 31-44%; in 2002, 15 – 17%
Kansas City, MO	Metro	1998 (?) to Present	Fares reduced from $1.00 to $0.25 on red and orange days	6 – 22%	In first years, 15 –22%. Last year, 6 – 10%. Don't know if increase is due to regular riders or new riders.
Tulsa, OK		1990 to Present	Free transit on ozone days	35 – 55%	Most of the increase is from regular riders, not new riders.
St. Louis, MO		1999 to Present	Deeply discount transit passes for summer quarter.	Unknown	Ridership counts are not available.
New Jersey	NJ Transit	1999 to Present	Employers purchase reduced fare tickets ($2.00 down from $2.20 to $14.00) to sell to employees for use on days forecast to be orange or red. For trips within NJ only.	Negligible	Ridership counts are not available. Program is a "Try Transit" program, not so much a program to reduce emissions
Cincinnati, OH	Metro	1996 to Present	Offer $0.50 fares (down from $0.65 to $1.50) between June 1 and Labor day	Up to 15%	Increases of 15% occurred in early years. Last 2 years, less than 10%
Houston, TX	Metro	1997 - 1999	Half-off fares during the month of August	Unknown	Are looking in archives for study
Portland, OR	Tri-Met	1994 - 1997	Free rides on days forecast to be high ozone	Negligible	Anecdotal evidence only
Fort Worth, TX	T	1997 - 1999	Offer $0.25 fares (down from $0.80) on days forecast to be high ozone	10%	With free fares buses became crowded with riders seeking AC. Estimate up to 10% increase w/reduced fares.
Dallas, TX	DART	1998 - 2000	Fares are $0.50 (down from $1.00 and up) on days forecast to be high ozone	Unknown	Detailed before and after data did not reveal any trends. Sometimes ridership decreased on ozone days.
N. Virginia Maryland	Metro	1995 to Present	Free rides for trips between suburbs and into DC, but not for rides heading out of DC	Unknown	Evaluation was not conducted

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